

Third AJRR Annual Report  
on Hip and Knee Arthroplasty Data

# Dedication

This Annual Report is dedicated to the founders, leaders, and staff of national joint registries of Scandinavia, the United Kingdom, and Australia, whose work continues to demonstrate the great value of national joint registries to the orthopaedic community and serves as an inspiration for what AJRR is working to accomplish in the United States.

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# Foreword

Together with the Board of Directors and staff of the American Joint Replacement Registry (AJRR), I am delighted to present the third AJRR Annual Report. AJRR continues to grow rapidly and demonstrate notable progress.

Our 2016 Annual Report reflects data collected from 2012 through 2015. Previous reports were titled 2013 and 2014 to correspond with the year of the data contained within the reports. This year's cover is labeled with the year we published the report, and this shall be our protocol moving forward.

Included in the report are data on 427,181 procedures from 416 hospitals and 3,170 surgeons. This is a 102% increase in procedures, a 75% increase in reporting hospitals, and a 41% increase in surgeons compared to last year's report. Our goal is to capture over 90% of all joint replacements performed annually in the United States.

As with the 2013 and 2014 reports, readers will find valuable descriptive information on the practice of total joint arthroplasty in the United States. For hip arthroplasty, the report includes new information on trends related to the use of ceramic femoral heads, antioxidant polyethylene, dual mobility liners, and modular necks. The report also highlights trends related to the surgical treatment for femoral neck fractures and management of hip instability. For knee arthroplasty, the report provides information on changes in use of cross-linked and antioxidant polyethylene, unicompartmental arthroplasty, and cruciate preservation/substitution. The report also supplies important current information on the causes of revision for both hips and knees, with a special focus on reasons for early revision in U.S. practice.

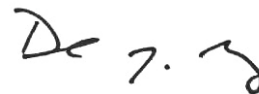
Along with the procedural focus of the Registry, AJRR has engaged in numerous efforts to expand the depth and breadth of our work. 2015 saw the implementation of ICD-10. AJRR began accepting Current Procedural Terminology (CPT) codes, which allows easier data submission from individual surgeons and physician practice groups. We are rapidly upgrading systems to capture patient-reported outcome measures and data needed for risk adjustment. AJRR's component database continues to mature with assistance from many stakeholders and other arthroplasty registries around the world. AJRR added 50,000 component codes this year, resulting in a database that includes over 115,000 implants. External collaborations with both orthopaedic and academic partners continue to assist AJRR in achieving its mission of improving orthopaedics by providing data back to stakeholders.

A major initiative that began in 2015 was the Centers for Medicare & Medicaid Services (CMS) Comprehensive Care for Joint Replacement (CJR) bundled payment initiative. AJRR is poised to address needs related to CJR, including a comprehensive platform for the capture of patient-reported outcome measures.

We eagerly await sufficient comprehensive longitudinal data to conduct survivorship analysis and provide risk adjusted outcome information to stakeholders. To reach these capabilities, AJRR continues to expand data collection and reporting infrastructure. Since last year's report, the staff has expanded to 20, and plans are currently underway to improve the technology underlying the Registry platform. This will provide users greater functionality and the ability to compare data against national benchmarks. AJRR continues final integration efforts with the California Joint Replacement Registry (CJRR). Like last year, we are publishing the CJRR annual report at the same time as this AJRR Report. In 2015, AJRR assumed management of CJRR under the leadership of James I. Huddleston, III, MD.

I would like to extend my gratitude to the committed staff at AJRR for many accomplishments in 2016. I also would like to thank AJRR's Medical Director David Lewallen, MD for his continued efforts to ensure a robust and successful arthroplasty Registry, and Terence Gioe, MD for his work compiling this AJRR annual report.

AJRR is growing quickly and moving fast to enable the comprehensive collection of patient, practice, and implant information that with careful analysis will improve the practice and results of joint replacement in the United States.



Daniel J. Berry, MD  
Chair, AJRR Board of Directors

# Executive Summary

The AJRR continued to expand in 2015, increasing enrollment to 612 hospitals from 417 in 2014, with data collection from 416 of those institutions. Due to a 102% increase in joint arthroplasty procedures compared to 2014, this report reflects over 427,000 cumulative procedures between 2012 and the end of 2015.

The U.S. Department of Health and Human Services mandated that all U.S. hospitals complete the conversion to International Classification of Disease, Tenth Revision procedural codes by October 1, 2015. Many of AJRR's participating hospitals were thus focused on the conversion and implementation process during the latter portion of 2015, causing a temporary delay of data submissions. Nevertheless, the data in this year's report are more extensive than in previous years.

Over 3,100 surgeons from all 50 states and the District of Columbia performed arthroplasty procedures at the full spectrum of hospital sizes and types. Similar to previous years, arthroplasty patients in this U.S. sample had a mean age of 66.5 years, and were 40.8% male and 59.2% female. Revision hip arthroplasty patients are slightly older than those undergoing primary hip arthroplasty (mean 67.1 years versus 65.4), but those undergoing revision knee arthroplasty are considerably younger than their primary knee arthroplasty counterparts (61.8 years versus 66.4).

With 161,040 procedures submitted in 2015, AJRR represents approximately 15% of the total procedures performed annually in the United States. As a result, the information in this report reflects only a snapshot of the U.S. experience with hip and knee arthroplasty. Data will continue to remain descriptive until longer-term follow up with implant-specific survivorship (and the influence of surgeon and patient factors) is possible.

Even so, important descriptive data are included here. For example, this report shows a significant increase in the use of ceramic femoral head usage. The analysis also shows ceramic heads are used in a much higher percentage of younger than older patients, but that ceramic head use is also growing among older patients. Additionally, there has been a significant increase from 2012 to 2015 in the use of antioxidant polyethylene acetabular liners. Data also show a

marginally significant increase in the percentage of total hip arthroplasty performed for femoral neck fracture compared to hemiarthroplasty. In this sample, cementless stems and unipolar heads are preferred for hemiarthroplasty by U.S. surgeons across the spectrum of patient age. Among more recent arthroplasty designs studied in the Registry, the use of modular neck stems has decreased and the use of dual mobility liners has increased during the same period.

Analyses indicate that there has been a slight downward trend in the use of unicompartmental knee implants between 2012 and 2015, which now represent approximately 5% of primary knee arthroplasty procedures. While unicompartmental arthroplasty is performed in the majority of hospitals, only approximately 30% of surgeons reported performing these procedures in 2015. Patellofemoral arthroplasty was found to represent less than 1% of knee arthroplasties. Similar to the hip data, there has been a significant increase in the use of antioxidant polyethylene in both primary and revision knee arthroplasty. The use of mobile bearing designs remains fairly constant in primary knee arthroplasty at almost 7% over the years studied.

Revision burden, which can be seen as a crude measure of the success of arthroplasty procedures, was 10.2% for hips and 8.7% for knees per year. This is consistent with the values reported for other large national registries. While there has been slight variability from year to year, these numbers have been relatively constant over the 2012 to 2015 reporting period.

Procedural analyses and other information in this report provide a synopsis of the national experience related to total joint arthroplasty and reflect the trending experience with newer technology, such as dual mobility liners and modular neck stem. Along with related initiatives, AJRR is quickly becoming the source for relevant and timely data pertaining to arthroplasty practice in the United States.



# About AJRR

The American Joint Replacement Registry is a not-for-profit 501(c)(3) tax-exempt organization for data collection and quality-improvement initiatives for total hip and knee replacements. AJRR is a collaborative effort supported by the American Academy of Orthopaedic Surgeons (AAOS), the American Association of Hip and Knee Surgeons (AAHKS), The Hip Society, The Knee Society, hospitals, ambulatory surgery centers (ASC), commercial health plans, medical device manufacturers, and contributions from individual orthopaedic surgeons.

## Governance and Structure

AJRR is unique compared to other national registries by virtue of its multi-stakeholder support and governance. During the evolution of the U.S. arthroplasty Registry effort, a conscientious decision was made to expand from an orthopaedic surgeon-driven model to a more inclusive model involving all categories of individuals and organizations involved in the delivery of arthroplasty care. As a result, AJRR's Board of Directors is derived not only from orthopaedic surgery societies and associations, but also from organizations that represent medical device manufacturers, hospitals, health plans, and patient advocacy groups. In 2015, AJRR added an AJRR representative appointed-seat, thus instituting a 15-member board, which met formally in person three times over the course of the year. The Board is responsible for AJRR's strategic direction and for oversight of its activities and operations.

Initial financial support for the formation of AJRR was provided by AAOS. After formalization of the multi-stakeholder model, AJRR evolved to include varying levels of financial support from virtually all of the participating stakeholder groups, with the exception of the public. AJRR is currently evolving toward an organization largely supported by subscriptions or software licensing fees, currently paid by a subset of hospitals desiring on-demand access and display of their own data benchmarked to the national sample. In 2015, the AJRR platform expanded to include ASCs,

practice groups, and individual surgeons interested in similar data.

Currently, AJRR is financially supported by AAOS, AAHKS, The Hip Society, The Knee Society, hospitals and ASCs, and medical device manufacturers (via the Advanced Medical Technology Association – AdvaMed). The 2015 industry contributors included DePuy Synthes, DJO Surgical, Exactech, Smith & Nephew, Stryker, and Zimmer Biomet.\*

\* Zimmer and Biomet merged in June 2015 but contributed as separate entities before the merger

## AJRR Board of Directors

In 2015, the AJRR Chair of the Board of Directors was Daniel J. Berry, MD who is L. Z. Gund Professor of Orthopedic Surgery at Mayo Clinic and a member of the Mayo Clinic Board of Trustees. Dr. Berry represents The Hip Society.

The Executive Committee was comprised of Dr. Berry; Vice Chair Kevin J. Bozic, MD, MBA of The University of Texas at Austin; Secretary/Treasurer David E. Mino, MD, MBA of Cigna, Inc.; and Pamela L. Plouhar, PhD of DePuy Synthes, Inc.

The following were the 2015 AJRR Board of Directors:

### AAOS Representatives:

**Michael R. Dayton, MD**, University of Colorado (Aurora, Colo.)

**Gregory B. Krivchenia II, MD**, First Settlement Orthopaedics (Marietta, Ohio)

**E. Anthony Rankin, MD**, Providence Hospital (Washington, D.C.)

**Scott M. Sporer, MD**, Midwest Orthopaedics at Rush and Central DuPage Hospital (Chicago, Ill.)

### AJRR Representative:

**Kevin J. Bozic, MD, MBA**, The University of Texas at Austin (Austin, Texas)

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## MISSION

AJRR's mission is to focus on improving care for patients who receive hip and knee replacements. By collecting and reporting data, AJRR provides actionable information to guide physicians and patient decision making to improve care. It empowers health care organizations to enhance the patient experience and benchmark performance; orthopaedic surgeons to reduce complications and revision rates; device manufacturers to strengthen post-market surveillance; and health plans to effectively manage costs.

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*Orthopaedic Specialty Society Representatives:*

**Daniel J. Berry, MD**, Mayo Clinic (The Hip Society)  
(Rochester, Minn.)

**Craig J. Della Valle, MD**, Midwest Orthopaedics at Rush  
(The Knee Society) (Chicago, Ill.)

**Brian S. Parsley, MD**, University of Texas Health  
Science Center at Houston and Baylor College of  
Medicine (AAHKS) (Houston, Texas)

**Bryan D. Springer, MD**, OrthoCarolina (AAHKS)  
(Charlotte, N.C.)

*Advanced Medical Technology Association (AdvaMed)  
Representatives:*

**Blair Fraser**, Smith & Nephew, Inc. (Cordova, Tenn.)

**Pamela L. Plouhar, PhD**, DePuy Synthes, Inc.  
(Warsaw, Ind.)

*America's Health Insurance Plans (AHIP)  
Representatives:*

**Robert L. Krebs**, Anthem, Inc. (Richmond, Va.)

**David E. Mino, MD, MBA**, Cigna, Inc. (Blue Bell, Pa.)

*American Hospital Association (AHA) Representative:*

**Kristen Murtos, MBA**, NorthShore University  
HealthSystem (Evanston, Ill.)

*Public Representative:*

**Colin Nelson**, Informed Medical Decisions Foundation  
(Boston, Mass.)

At the conclusion of 2015, Drs. Plouhar and Rankin completed their terms of service on the AJRR Board and rotated off. Their many collective years of service are greatly appreciated. AJRR is especially grateful to Dr. Rankin as he was the last of the original Board members to rotate off. We thank him for his service as Chair of the Regulatory Committee and all that he accomplished on behalf of the committee.

## Public Advisory Board

AJRR has a Public Advisory Board (PAB). This group was established at AJRR's inception to provide direct input to the AJRR Board from both the patient and the public perspective. They have been integral to AJRR's success thus far, ensuring that there is a public voice in the Registry's governance, deliberations, data collection, reporting, and decision making. The PAB members are drawn from a wide variety of public advocacy groups and members of the public who have had joint arthroplasties themselves.

In 2015, the Chair of the Public Advisory Board was **Colin Nelson**. Mr. Nelson was Senior Research Associate at the Informed Medical Decisions Foundation, where he oversaw a portfolio of shared decision-making programs in orthopaedics and spine care. Other 2015 PAB members were as follows:

**John A. Canning, Jr.**, Chairman, Madison Dearborn Partners, LLC (Chicago, Ill.)

**David G. Mekemson**, Patient Representative (Chicago, Ill.)

**Martha Nolan, JD**, Vice President, Public Policy, Society for Women's Health Research (Washington, D.C.)

**Margaret VanAmringe, MHS**, Vice President for Public Policy and Government Relations, The Joint Commission (Washington, D.C.)

## AJRR Commission

Established in 2014, the AJRR Commission is a group of six arthroplasty specialist orthopaedic surgeons without relevant financial conflicts who serve as independent reviewers of the data published in this AJRR Annual Report. The Commission made the final recommendation to the AJRR Board of Directors regarding the content of the Annual Report. The Commission members are known only to the AJRR Board of Directors to ensure members' independence and allow them to avoid undue outside influence pertaining to the report.

## VISION

AJRR seeks to become the National Registry for total joint replacement, beginning with capturing 90% of all hip and knee replacements in the United States, and to leverage this comprehensive data to enhance orthopaedic quality of care, improve patient outcomes and safety, reduce costs, and advance orthopaedic science and bioengineering.

## AJRR Committees

Besides the Executive Committee, AJRR has three standing committees, each of which is described below. Full membership can be found in Appendix A.

The **Data Management Committee** is responsible for recommendations to the Board concerning data elements to be included in AJRR and the methods by which the selected data are analyzed and reported. The committee is responsible for recommendations concerning yearly areas of interest for the Annual Report along with reviewing proposed research projects. Annually, the committee submits a report to the AJRR Commission to validate the findings of the Data Management Committee.

*Chair: Bryan D. Springer, MD*

The **Finance and Compensation Committee's** responsibility is to review monthly statements and reports in order to keep the AJRR Board abreast of spending and incoming funding and contributions from outside stakeholders and the public. Annually, the committee makes a recommendation to the Board of Directors on all facets of budgeting and investment planning.

*Chair: David E. Mino, MD, MBA*

The **Regulatory Committee** is a group of professionals who monitor and respond to the influencers of pertinent socioeconomic and legislative issues. This committee reports to the Board on governmental opportunities and obstacles affecting the development of AJRR.

*Chair: E. Anthony Rankin, MD*

## 2015 AJRR Staff

**Jeffrey P. Knezovich, CAE**, Executive Director

**David G. Lewallen, MD**, Medical Director\*

**Jillian Bachelor**, Data Technician

**Kristine F. Baldwin, MS**, Data Submission Analyst

**Lori Boukas, MS**, Director of Marketing and Communications

**Judi Buckalew, RN, BSN, MPH, CAE**, Government Relations Specialist\*

**Alyssa N. Burns, MHA**, Program Coordinator

**September R. Cahue, MPH**, Senior Registry Analyst

**Philip J. Dwyer**, Program Coordinator

**Caryn D. Etkin, PhD, MPH**, Director of Analytics

**Marisol Goss**, Clinical Data Registry Policy and Advocacy Coordinator\*

**Steve Hamada**, Senior Software Engineer

**Savana M. Martin**, Program Coordinator

**Randolph R. Meinzer**, Director of Information Technology

**Erik S. Michalesko**, Marketing and Communications Specialist

*\* Denotes part-time/contract staff*

## From the Editor

I am pleased to rejoin the AJRR team in a new role as the editor of the Annual Report. I come to this position after having served on AJRR's Board of Directors from 2010 to 2014 as The Knee Society representative. A national total joint implant Registry for the United States, with the tremendous volume, technical sophistication, and breadth of experience that can be brought to bear, has long been a personal dream.

The growth of AJRR in the interim since I left the Board has been both astounding and gratifying. Still, we all recognize that our Registry is a nascent one, and our efforts must continue if we are to bring value to all stakeholders involved and make AJRR's Annual Report an eagerly anticipated publication. I look forward to guiding those efforts around the preparation of the Annual Report this year and in the years to come.

Terence J. Gioe, MD—Editor, AJRR Annual Report

# 2015 Achievements

## Growth

- Added 195 hospitals for a total of 612 participants for a 47% increase over 2014
- Hospital enrollment covered all 50 states and the District of Columbia
- Over 427,000 procedures received
- Data as shown reflect 416 hospitals and 3,168 surgeons
- Increased enrollment of ASCs and private practice groups
- Hired additional personnel for a total of 15 staff members
- Published second AJRR Annual Report, which reflects 211,721 procedures

## Infrastructure

- Became a self-sustaining, independent organization on January 1, no longer a formal entity of AAOS
- Developed strategic 2016-2018 Business Report & Plan in concert with AJRR's independence from AAOS
- Completed transfer of the California Joint Replacement Registry (CJRR) to AJRR, streamlining business operations under one unit
- Concluded the requirements to implement ICD-10 on AJRR's data system, adhering to the October 1 launch
- Added the capability to collect Current Procedural Terminology (CPT) codes
- Launched new website at [www.ajrr.net](http://www.ajrr.net)

- Included AJRR Total Joint Replacement Risk Calculator on the website with free access to any interested parties
- Originated AJRR User Group Network (UNet), a forum for those who participate in the Registry to share ideas and best practices

## Quality Initiatives

- Designated a Qualified Clinical Data Registry (QCDR) by the Centers for Medicare & Medicaid Services (CMS)---allowing for submission of Physician Quality Reporting System (PQRS) data
- Participated in the patient-reported outcomes (PRO) PRO Summit for Total Joint Arthroplasty with AAHKS, AAOS, The Hip Society, The Knee Society, CMS, Yale New Haven Health Services Corporation (YNHHSC)/Center for Outcomes Research and Evaluation (CORE), National Committee for Quality Assurance (NCQA), Mathematica, CECity, and Blue Cross Blue Shield Association
  - Obtained a consensus regarding the PRO and risk variables suitable for total hip and knee arthroplasty performance measures: PROs include HOOS, JR.; KOOS, JR.; Patient-Reported Outcomes Measurement Information System (PROMIS) 10-Item Global Health; Veterans Rand 12-Item Health Survey
- Released Level III PRO platform
- Awarded subcontract for partnership with Weill Cornell Medical College on a grant from the U.S. Food and Drug Administration (U01 FD005478) Creating National Surveillance Infrastructure for Priority Medical Devices

## 2015 Milestones



Added 195 hospitals for a total of 612 participants for a 47% increase over 2014



AJRR USER GROUP NETWORK

Unet Advisory Board helped launch online community



3,168 surgeons in Registry



Completed transfer of the California Joint Replacement Registry (CJRR) to AJRR



Released Level III/ patient-reported outcomes (PRO) platform

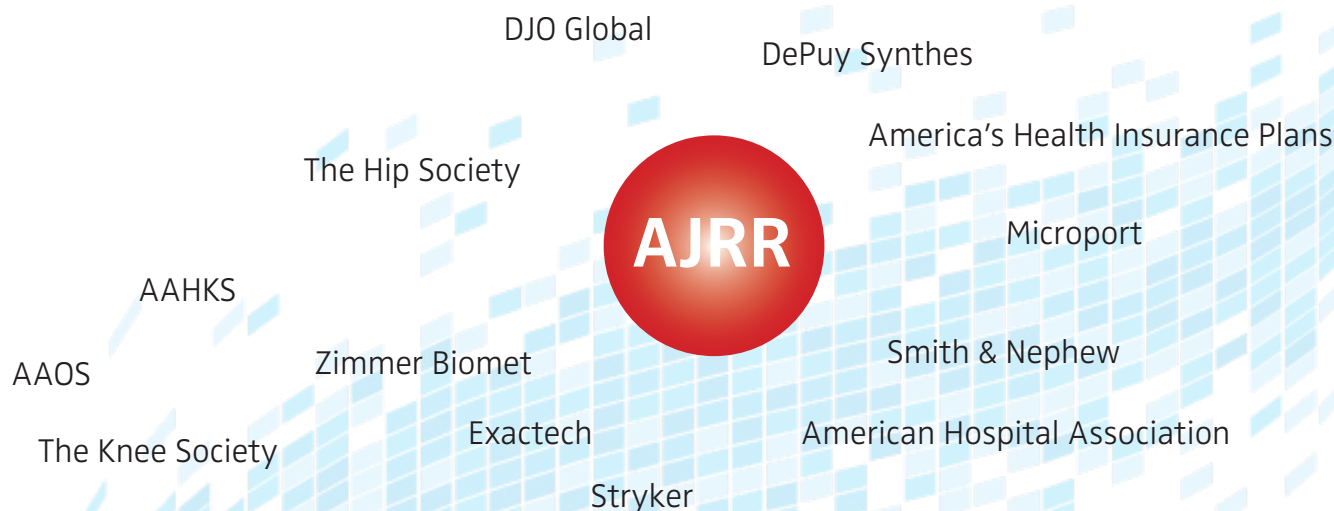


## Information Technology

The AJRR Information Technology (IT) team achieved several milestones throughout 2015. The large effort to expand the Registry platform to support the ICD-10 codes and conversion of existing data from ICD-9 was a success. We look forward to the more comprehensive analysis and outcome measure reporting the new ICD-10 codes will offer AJRR in the future. AJRR would like to thank all participants for the tremendous effort undertaken to not only migrate their internal electronic health records (EHR) systems to support the new coding format, but also modify the Registry reporting format to include the new ICD-10 procedure and diagnosis codes for the data submitted to AJRR.

AJRR continues to expand the IT Department to manage growth and provide the resources required to maintain the highest level of service and data quality within the national Registry. AJRR IT also enhanced the medical device component database library, increasing the number of available device attributes from 9 to 60, and added support for the recent U.S. Food and Drug Administration's unique device identification (UDI) mandate for medical devices.

To facilitate electronic data transfers, AJRR has established relationships and business agreements with orthopaedic charting and EHR. Vendor agreements or pre-defined AJRR reports from EHR vendors relieve the burden of creating custom reports on AJRR's behalf. At the end of 2015, AJRR had agreements with ten orthopaedic charting vendors: Arthrex; Consensus Medical Systems; InVivoLink, Inc.; MedTrak, Inc.; [m]pirik; Ortech, Inc.; OrthoSensor, Inc.; PA & Associates Healthcare, LLC; URS-Oberd, Inc.; and Wellpepper, Inc. These vendors submit data directly to AJRR on behalf of a participating hospital. AJRR IT staff continues to collaborate with Epic and Cerner on predefined AJRR reporting modules. Epic released an AJRR reporting module that functions with their latest EHR and OpTime Operating Room Management System software release. Cerner released a similar reporting module in 2014 in conjunction with their SurgiNet system. AJRR technology staff continues to pursue similar partnerships with other EHR vendors with a goal of eliminating independent IT efforts for our current and future hospital participants



Thanks to our sponsors for their support and contributions.

The AJRR IT team introduced support for patient-reported outcomes (PRO) data collection within the platform. This system allows registered participants to administer web-based pre- and post-operative survey instruments or submit a file upload of PRO data. The AJRR platform accommodates several PRO instruments results of which can be viewed in online reports and dashboards.

### **Data Completeness and Quality Monitoring**

The AJRR data systems verify incoming data by checking conformance to rules contained in the data system. AJRR staff continues to interact individually with hospitals to ensure that all submitting sites conform to AJRR specifications (see Appendix B for data elements). The IT staff has been verifying the content of hospital data since its inception. The submission process includes a test submission, data review, and timely feedback to participating sites in an effort to remove possible sources of error prior to the delivery of patient information. AJRR continues to work with all submitting sites on data content improvements in the areas of component catalog and lot numbers, formatting of ICD-10 codes. In addition, AJRR processes all data through a comprehensive set of electronic validation rules and partners annually with a major research university to perform an audit of a sample set of partners and submitted data against the respective provider's EHR for those patients as a continuous quality improvement process.

To develop the contents of the Annual Report, AJRR's Data Committee convenes regularly each spring to review the previous year's report and propose Yearly Areas of Interest to include in the new Annual Report. Each member of the Data Committee is given the opportunity to offer his or her suggestions with a subsequent full committee discussion on each topic. During the final call, the group comes to a consensus regarding the topics to be presented in the report. This year the Data Committee convened calls on March 22, April 25, and June 6. After the final call, the Editor had recurrent discussions with staff, the Data Committee Chair, and the Medical Director about the development of the report with suggestions for further refined analysis when warranted.

New to this Annual Report is the addition of a statistical consultant, Exponent, Inc. Exponent has considerable expertise in orthopaedics, including implant properties, usage and design, and epidemiologic trends in total joint arthroplasty. In addition to conducting statistical analyses for the report, Exponent provided AJRR with guidance as to the appropriateness of data analysis, proper presentation of findings, and data interpretation. Statistical analyses were performed using SAS software v. 9.4 (SAS Institute, Cary, NC).

### **Component Reference Database and Component Analysis**

In 2015, AJRR led a program to significantly enhance its component database. AJRR continues to work in partnership with the AdvaMed Orthopaedic Sector, the International Consortium of Orthopaedic Registries (ICOR), the International Society of Arthroplasty Registers (ISAR), along with the Australian Orthopaedic Association National Joint Replacement Registry (AOANJRR), and the National Joint Registry (NJR) for England, Wales, Northern Ireland, and the Isle of Man to harmonize the component definitions, attributes, and detailed data to provide a consistent framework for component analysis requested by AJRR stakeholders. The number of database fields populated to identify component attributes expanded from nine fields to 60. In conjunction with this effort, AJRR acquired additional component data from Orthopaedic Network News and ICOR. As a result, AJRR added approximately 50,000 components to the reference data system, which expanded the database to over 115,000 orthopaedic implant components. The aforementioned component attribute information populated the newly created component fields.

## Audit of Registry Data

AJRR is committed to ensuring that data reports are valid and accurate. In addition to internal quality controls, AJRR completes an annual external audit in conjunction with the West Virginia Medical Institute (WVMI). WVMI has a long history of collaboration with nonprofit medical organizations, with a specific focus on validating Registry and health record data.

In the spring of 2016, WVMI began an audit of N=18 (4.3%) randomly selected hospitals that submitted data to AJRR from January 1 to September 30, 2015. The time period was shortened to address the ICD-10 transition that was implemented in October 2015. Therefore, only ICD-9 procedure and diagnosis codes were included in the audit. WVMI and AJRR undertook an effort to obtain 30 randomly selected procedures files from the 18 audit hospitals (which reflected at least 80% power). The hospitals represented urban, rural, small, and large locations. The audit reviewed two aspects of data submission: (1) an accuracy review of the 30 randomly selected procedures, to ensure that data submitted to AJRR correctly reflected the data in the hospital medical records; and (2) a completeness review of data submitted to AJRR for a randomly selected month in 2015, to ensure that AJRR received all procedures performed at that hospital (i.e., review of “cherry picking”). The audit project was completed in early August 2016.

In summary, the overall audit agreement rate for the medical record review was 96.9%. This represents an improvement from the score of 91.5% from the audit of 2014 data. Of the 18 hospitals, 11 (61.1%) had agreement rates above 97.0%. No data element(s) were problematic. The types of errors (e.g., mismatches in surgeon first name, surgeon NPI, principal diagnosis code, etc.) were variable across hospitals. In regards to diagnosis codes, multiple ICD-9 diagnosis codes may be utilized for a total joint procedure. The primary ICD-9 diagnosis codes that hospitals submitted to AJRR were appropriate for the specific total joint procedure. However, the diagnosis code submitted to AJRR was listed as a secondary diagnosis code in the medical records.

The overall record completeness assessment rate was 68.5%, down from 85.3% last year. A major reason for a lower agreement rate compared to the previous year was due to a corrupted file that caused one hospital to receive a score of 3.9%. AJRR compared the WVMI hospital file to AJRR's original, correct file and there was a 100% agreement rate, which would have increased the overall completeness assessment rate to 76.2%. Of the 18 hospitals, eight (44.4%) had an agreement rate of 97.0% or better. Of those, six hospitals had a 100% agreement rate. Additionally, audit hospitals submitted a total of 1,075 records to WVMI. 107 records (10.0%) were not in AJRR's database, while 232 records (21.6%) had one or more accuracy issues preventing them from matching with the Registry. There were no similarities or trends observed to suggest a reason why these records were not submitted to AJRR. Likewise, there were no anomalous observations to suggest any “cherry picking” of records for non-submission on the part of hospitals. The poorer accuracy issues this year were due to a few hospitals that had a consistent discrepancy between AJRR and WVMI files. For example, one hospital submitted to WVMI the surgeon's practice group NPI, instead of his own professional NPI (AJRR had the correct NPI). In general, AJRR and WVMI were pleased with the results, and the discussions with hospitals generally lead to process improvement.

Of the 18 audited hospitals, 11 (61.1%)  
had agreement rates above 97.0%.

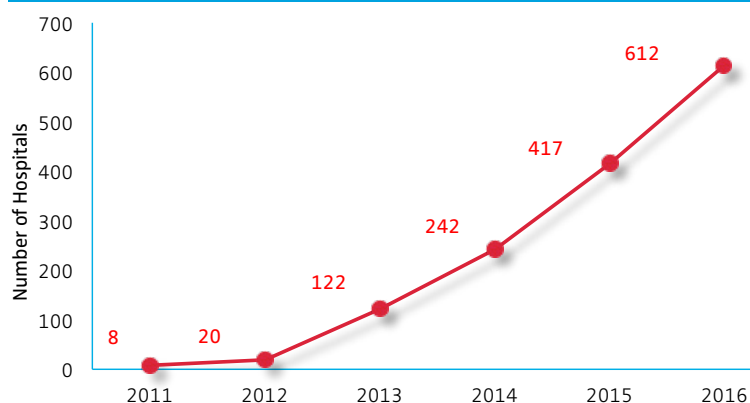
11 | 97%

# Overall Results

## Hospital Enrollment

As in previous years, a primary focus in 2015 was to increase the number of hospitals that participate in the Registry. Three staff members were dedicated to enroll new facilities and ensure that data were submitted in a timely fashion. As of December 31, 2015, enrollment stood at 612 hospitals, representing all 50 states and the District of Columbia (see Figures 1 and 2 and Appendix C). This was an increase of 195 hospitals over 2014 and represents approximately 11% of the hospitals in the American Hospital Association (AHA) database, not all of which are institutions where joint arthroplasty is performed<sup>1</sup>. More than 50 hospitals in California and more than 30 in Illinois, Minnesota, Ohio, Texas, and Wisconsin participated while 12 other states had 16-24 participating hospitals.

**Figure 1: Hospital Enrollment 2011-2015**



**Figure 2: 2015 Geographic Distribution of AJRR Participating Hospitals (N=612)**

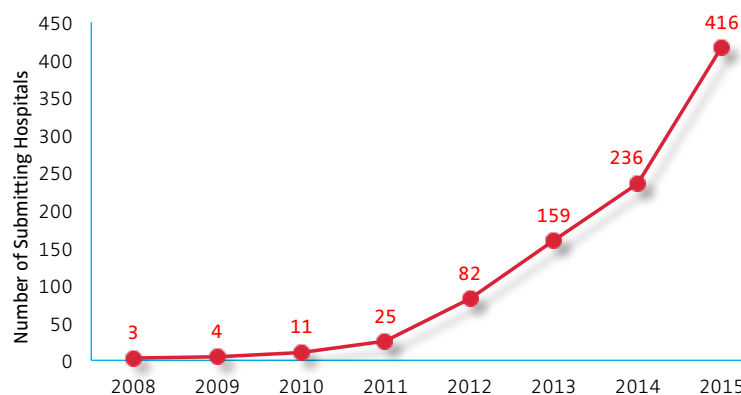


## Submitting Hospitals

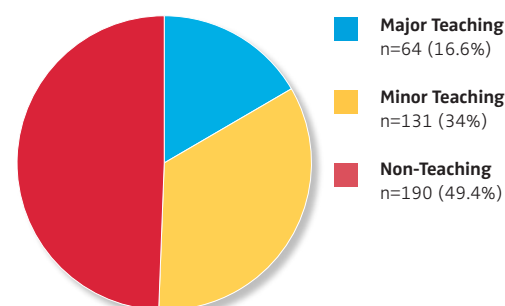
By the end of 2015, 416 hospitals were submitting data out of a total of 612 hospitals (68.0%) enrolled by that date (Figure 3). This represents a nearly 76% increase in the number of submitting hospitals from the previous year, due not only to increases in the numbers of hospitals enrolled but also to a decrease in the percentage of hospitals enrolled but not yet submitting data. Numerous factors contribute to the lag time between hospital enrollment and data submission, which presently stands at a median of 124 days. Among the factors that slowed progress in 2015 were large hospital system mergers and acquisitions, EMR changes, limited hospital information technology resources, and the move to ICD-10 coding.

As seen in Figures 4 and 5, arthroplasty procedures in the system are predominantly performed in large- to medium-sized hospitals and teaching facilities when compared to smaller community based non-teaching facilities. Some small hospitals may not be performing elective hip and knee arthroplasty at all. Thus, the distribution of hospitals submitting data to AJRR, while spanning the full range of hospital sizes and types, is somewhat weighted toward larger academic and teaching facilities when compared to AHA data on the profile of all hospitals nationally. Hospitals described as major or minor teaching facilities by the AHA make up 50% of the hospitals submitting data to AJRR (Figure 4) but are only 29% of the hospitals in the overall AHA profile (data not shown). These major and minor teaching hospitals accounted for n=101,205 (63%) of the procedures submitted to AJRR in 2015, while the non-teaching community hospitals (representing 49% of the hospitals submitting) accounted for n=55,273 (34%) of the procedures. The following figures describe the characteristics of the hospitals submitting data to AJRR. Please note some data were not available for submitting hospitals.

**Figure 3: Number of Hospitals Submitting Data by Year**



**Figure 4: Teaching Affiliation of Submitting Hospitals (N=385)**



Source: AHA Annual Survey Database Fiscal Year 2013

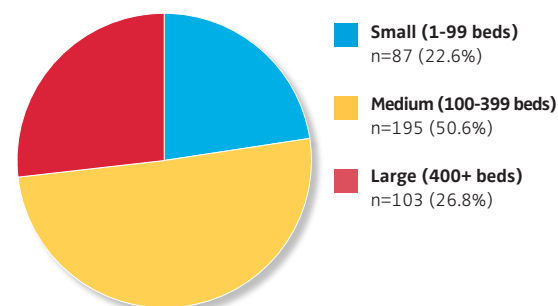
\* Not all submitting hospitals had relevant data in the AHA survey

Major Teaching Hospitals: those with Council of Teaching Hospitals designation (COTH)

Minor Teaching Hospitals: those approved to participate in residency and/or internship training by the Accreditation Council for Graduate Medical Education (ACGME), or American Osteopathic Association (AOA); or those with medical school affiliation reported to the American Medical Association

Non-Teaching Hospitals: those without COTH, ACGME, AOA, or Medical School (AMA) affiliation

**Figure 5: Hospital Size (Bed Count) of Submitting Hospitals (N=385)**



Source: AHA Annual Survey Database Fiscal Year 2013

\* Not all submitting hospitals had relevant data in the AHA survey



## Surgeon Participants

By the end of 2015, AJRR had collected data on arthroplasty procedures performed by more than 3,100 surgeons (Figure 6). AJRR hospitals report data for an average of 10.2 surgeons (range 1-32). These numbers include surgeons conducting only occasional hemiarthroplasty for hip fracture. Participating hospitals are required to submit data from all surgeons performing joint arthroplasty at their facility, and audit results over the past four years indicate hospitals do so.

Table 1 demonstrates that in 2015, surgeons conducted an average of 22.4 primary hip arthroplasties (THA) per year and 38.4 primary total knee arthroplasties (TKA) per year, with the upper end of the range for both TKA and THA approaching 500 procedures among contributing surgeons. Numbers from 2015 reveal that mean revision procedures per surgeon were much lower at 6.1 per year for hip revision and 5.9 per year for knee revision with the upper end of the range for revision THA and TKA between 110-120 revision procedures annually. Median values are lower, as expected, and have remained relatively stable over the last three years with the median number of annual primary procedures varying between 7-8 THAs and 16-21 TKAs during that time. This sample includes submissions from hospitals that may have submitted less than one year of data based on their AJRR enrollment date or the change to ICD-10 coding late in 2015. Actual totals may also be higher for some surgeons who operate at both an AJRR participating and non-participating hospital during the same year.

**Table 1: 2015 Average Procedural Volume for Participating Surgeons (N=3,168)**

|             | Total Surgeons | Total Procedures | Per Surgeon Mean | Per Surgeon Median | Interquartile Range (75th percentile – 25th percentile) |
|-------------|----------------|------------------|------------------|--------------------|---|
| <b>HIP</b>  |                |                  |                  |                    |   |
| Primary     | 2,572          | 57,673           | 22.4             | 8                  | 25  |
| Revision    | 1,101          | 6,688            | 6.1              | 3                  | 6   |
| <b>KNEE</b> |                |                  |                  |                    |   |
| Primary     | 2,281          | 87,593           | 38.4             | 20                 | 43  |
| Revision    | 1,538          | 9,086            | 5.9              | 3                  | 6   |

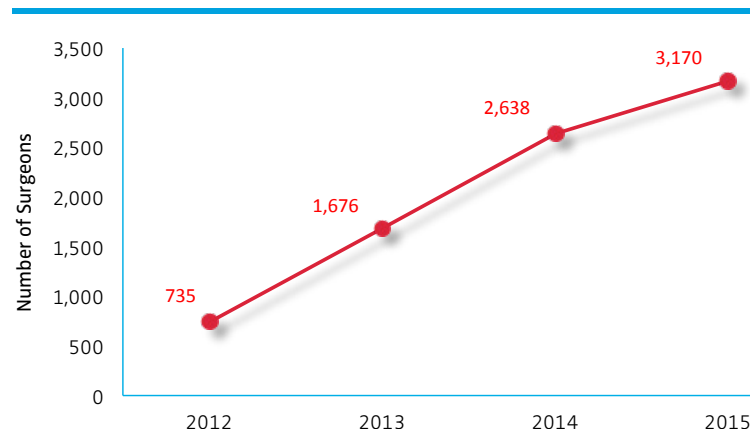
## Procedural Data Metrics

The data included for analysis reflect N=427,181 cumulative procedures submitted between 2012 and 2015 only, unless otherwise noted (Figure 7). Due to the small number of hospitals and surgeons submitting data prior to 2012, data from these earlier years could be skewed by sampling error especially with regard to descriptive summaries of hospital, patient, or implant characteristics and therefore were not included in those analyses. It should be noted that yearly volumes from prior years have also been updated as more hospitals come online and submit historical data from 2012-2014.

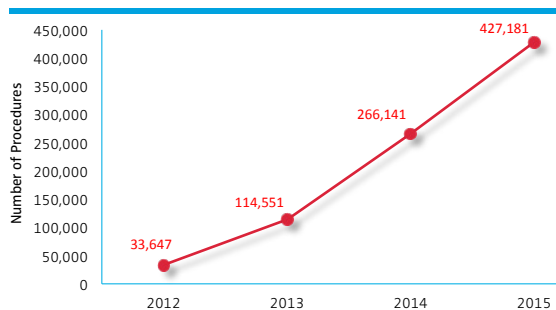
The cumulative procedural volume continues to grow exponentially. The cumulative volume reflected in this report demonstrates a 102% increase over the volume reported in last year's report. However, the year-by-year increase did not double as experienced in previous years.

As shown in Table 2, the yearly procedural volume increased 140% from 2012 to 2013, 87% between 2013 and 2014, but only 6% between 2014 and 2015. While AJRR added 195 more hospitals in 2015, it is apparent that the implementation of ICD-10 on October 1, 2015 became a significant impediment for rapid submission of data for both existing sites already submitting data and new hospitals. Figure 8 shows the procedural count for each quarter of 2015. While procedural count increased between the first and second quarters, the count decreased substantially in the second half of the year. Most notably, there was a 55% decrease in the number of procedures between the second and fourth quarters, when ICD-10 implementation began.

**Figure 6: Total Number of Surgeons Submitting Data by Year**



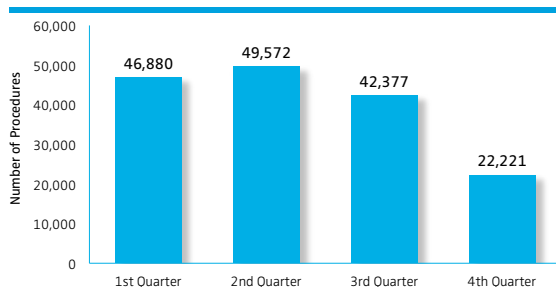
**Figure 7: Cumulative Procedural Volume**



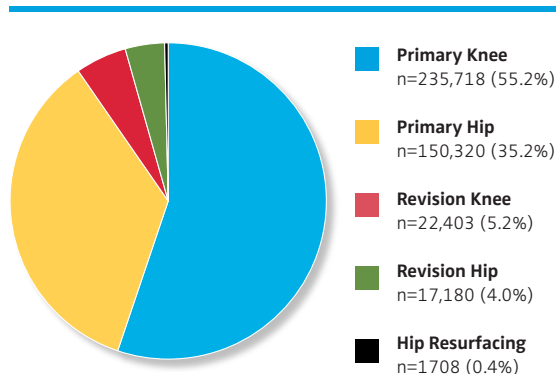
**Table 2: Procedural Volume by Year**

| YEAR | Total Number of Procedures |
|------|----------------------------|
| 2012 | 33,647                     |
| 2013 | 80,904                     |
| 2014 | 151,590                    |
| 2015 | 161,040                    |

**Figure 8: 2015 Procedural Volume by Quarter**



**Figure 9: Distribution of Procedures (N=427,181)**



See Appendix D for the complete list of procedure codes included in each category.

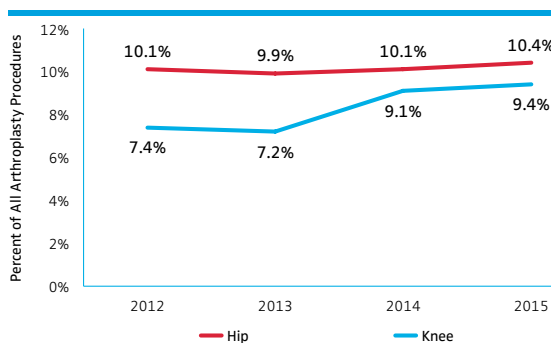
## Overall Results

Data presented in this version of the Annual Report reflect 427,181 procedures (primary and revision) performed between 2012 and 2015. Patients included had a mean age of 66.5 years (Standard Deviation = 11.3), including n=174,126 (40.8%) males and n=253,055 (59.2%) females. Females make up n=157,618 (61.1%) of the TKA population and slightly less n=95,437 (56.5%) of the THA population. Total knee procedures continue to predominate in AJRR, with all primary and revision TKAs representing n=258,121 (60.4%) of the volume compared to n=169,060 (39.6%) for THAs, numbers that have remained consistent year-to-year. The data in Figure 9 show the distribution of the major procedures (N=427,181) in AJRR's database.

## Revision Burden

Revision burden is the number of revision arthroplasties performed during a year compared to the total number of arthroplasties performed that same year. Revision burden may be seen as a general measure of arthroplasty success in a joint registry, and though influenced by numerous factors, can be used as a crude comparator between registries<sup>2</sup>. In 2015, there was a total of n=17,180 hip revisions out of a total of 169,060 hip arthroplasty procedures of all types. This translates to an overall revision burden of 10.2% for hips. For knee arthroplasties, there were 22,403 revision procedures out of the total of 258,121 knee arthroplasties recorded, for a knee revision burden of 8.7%. While there was slight variability from year to year, these numbers were relatively constant for hips (9.9% to 10.4%) with minor variation for knees (7.2% to 9.4%) (Figure 10). Similarly, these percentages are within the range of revision burden reported by five national joint registries (AOANJRR; NJR; New Zealand Joint Registry [NZJR]; Swedish Hip Arthroplasty Registry [SHAR]; and Swedish Knee Arthroplasty Registry [SKAR]) where the 2014 hip revision burden varied between 9.7 and 11.9% and the knee revision burden from 6.0 to 8.1%<sup>2</sup>.

**Figure 10: Revision Burden 2012-2015**

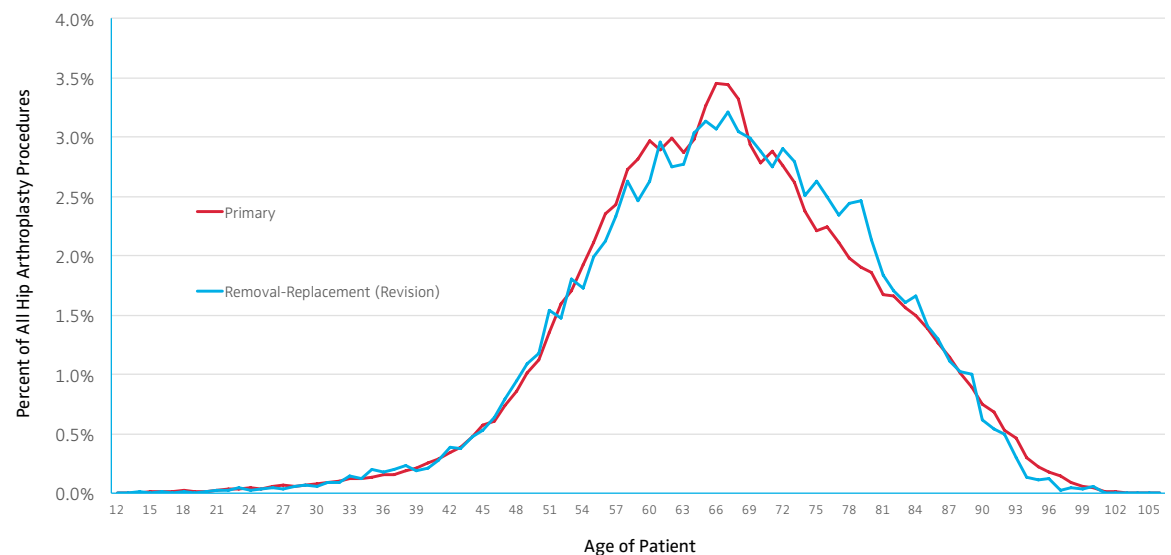


# Hip Arthroplasty

## Procedural Data: Hips

In hip arthroplasty, there is a significant difference in the average age between primary and revision patients ( $p$ -value  $<0.001$ ). The mean age of primary hip arthroplasty patients in 2015 was 65.4 years (SD 11.7) with the mean age of revision hip arthroplasty patients slightly higher at 67.1 (SD = 12.6) (Figure 11).

**Figure 11: Age Distribution of Hip Arthroplasty Procedures (N=169,060)**

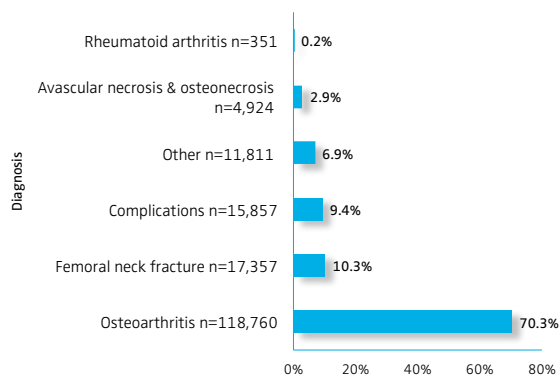


Osteoarthritis was the diagnosis at the time of surgery for approximately 70% of the patients undergoing hip arthroplasty (Figure 12). Fracture of the femoral neck was the next most common diagnosis, accounting for one in 10 arthroplasties performed. Rheumatoid arthritis, as noted in prior Annual Reports, accounts for only a very small fraction of the procedures in 2015 as newer medical therapies predominate in the treatment of this disease. Revision diagnoses are generally coded under ICD-9 code 996 or ICD-10 code T84-T85,

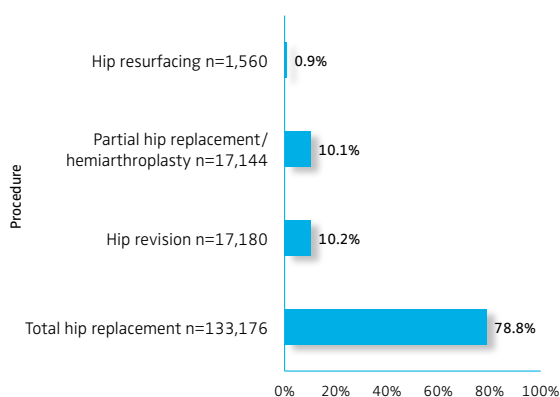
which comprises complications, or under the “other” category, accounting for the percentages seen for these diagnoses (Appendix E).

Total hip arthroplasty represents approximately 80% of the hip procedures performed in this sample, with hemiarthroplasty and revision arthroplasty accounting for the bulk of the remainder at about 10% each. Hip resurfacing in the U.S. now accounts for less than 1% of the overall arthroplasties (Figure 13).

**Figure 12: Diagnosis Codes for All Hip Arthroplasty Procedures (N=169,060)**



**Figure 13: Procedure Codes for All Hip Procedures (N=169,060)**



## Hemiarthroplasty

Arthroplasty for femoral neck fracture remains a commonly performed procedure with an aging but active demographic in the United States. Analyses were conducted for hemiarthroplasty in 2012-2015, although the reported incidence of this procedure was small in 2012 (Figure 14). Within our sample, hemiarthroplasty as a percentage of all total hip arthroplasty remains at approximately 10% (data not shown). As additional studies report advantages in pain relief, functional outcomes and reoperation rates for total hip arthroplasty for femoral neck fractures, our sample shows a marginally significant ( $p=.03$ ) increase in the percentage of THAs performed for this diagnosis over the last four years (Figure 15)<sup>3-6</sup>.

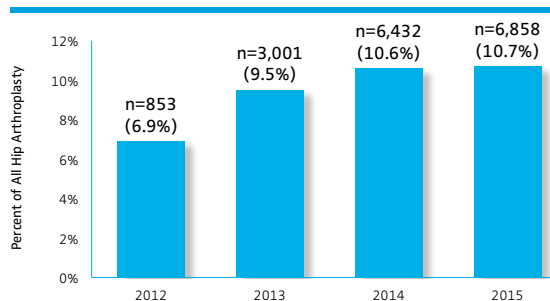
Although both cemented and cementless stems remain popular for hemiarthroplasty in the United States, since 2013 a majority of surgeons in our sample favor cementless designs (Figure 16). Our sample reflects a significant trend ( $p<0.001$ ) toward greater cemented stem usage with each additional

decade of life from 50 to >90 years old (Figure 17). However, even in the 80-90-year-old group, less than 50% of the hemiarthroplasties performed utilize cemented stems. A higher percentage of “unknowns” in this data set reflects some overlap in manufacturer stem designations and catalog numbers and inconsistent hospital coding for the use of cement itself.

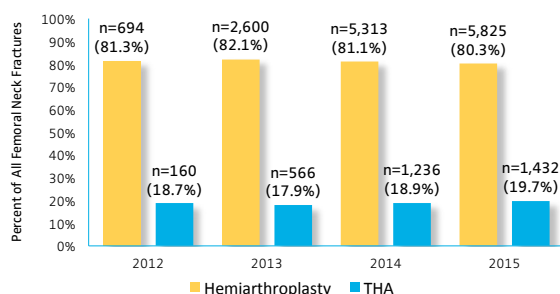
In our sample, unipolar heads are used in the majority (>50%) of cases with hemiarthroplasty stems from age 50-90, with a significant trend ( $p<0.001$ ) toward a greater proportion of unipolar heads (compared to bipolar heads) with each additional decade of life (Figure 18).

The majority (69.3%) of hemiarthroplasties for femoral neck fractures were performed on females (data not shown).

**Figure 14: Hemiarthroplasty as a Percentage of All Hip Arthroplasty Procedures in 2012-2015 (N=16,291)**



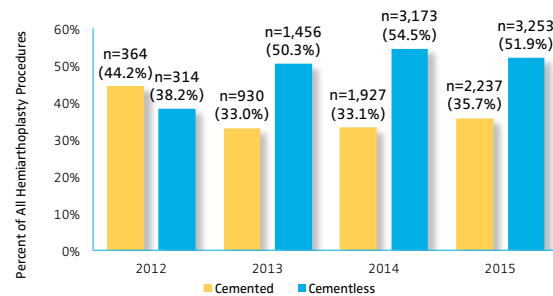
**Figure 15: Hemiarthroplasty and Total Hip Arthroplasty Performed for the Diagnosis of Femoral Neck Fracture (N=16,972)**



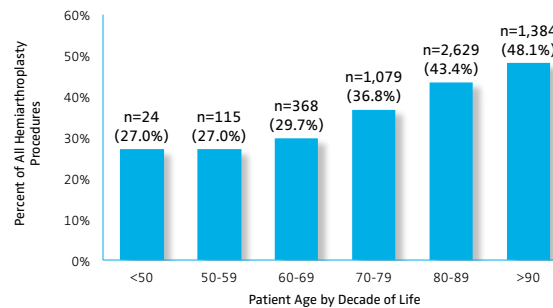
Hemiarthroplasty was defined as any ICD-9 procedure code of 81.52 or ICD-10 code of 0SRA0xx, 0SRE0xx, 0SRR0xx, and 0SRS0xx. ICD-9 diagnosis codes for femoral neck fracture included 733.14 (pathologic fracture, neck of femur) and all codes included in 820 (fracture of neck of femur).

ICD-10 diagnosis codes for femoral neck fracture included codes in the categories of M84 and S72 (fracture of femur).

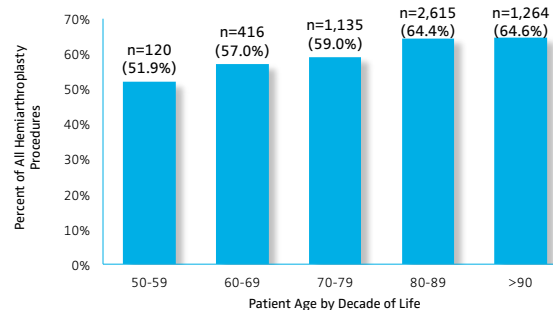
**Figure 16: Cemented and Cementless Femoral Stems in Hemiarthroplasty (N=15,701)**



**Figure 17: Percent of Cemented Stems in Hemiarthroplasty Based on Age (N=13,611)**



**Figure 18: Unipolar Heads in Hemiarthroplasty Based on Age (N=8,952)\***

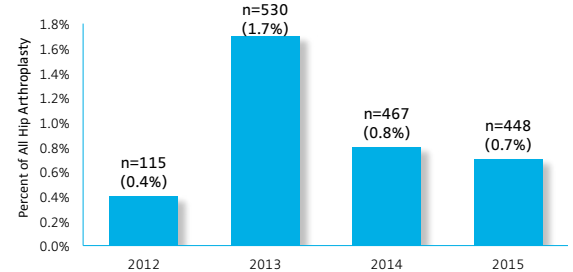


\* Unipolar heads for patients <50 were eliminated from this analysis as there were only 49 patients and a precise fraction of unipolar use for this age group cannot be estimated

## Hip Resurfacing

Hip resurfacing represented less than 1% of the total hip arthroplasty procedures in our sample, as surgeons have moved away from the metal-on-metal articulations that predominated (Figure 19). This procedure remains highly concentrated among both hospitals and surgeons; in 2015, resurfacing was done in only 48 AJRR hospitals by 63 surgeons. One surgeon accounted for 117 of the 448 resurfacing procedures (26%), while another performed 52 procedures (11.6%). The majority (86.1%) of the resurfacing procedures were performed on males, consistent with the practice in registries worldwide <sup>7,8</sup>.

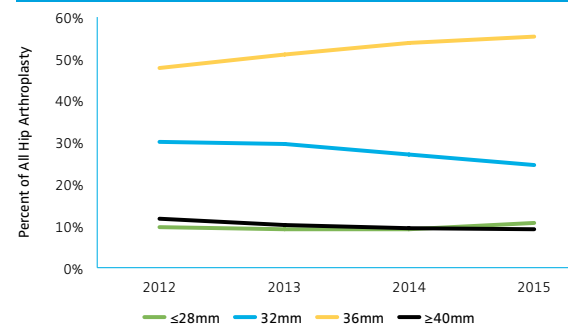
**Figure 19: Hip Resurfacing as a Percentage of All Hip Arthroplasty Procedures by Year (N=1,560)**



## Total Hip Arthroplasty

Femoral head size has remained relatively constant between 2012 and 2015, with 36mm heads used in approximately 50% of the procedures performed (Figure 20). The increased stability afforded by larger heads coupled with diminished volumetric wear concerns when these heads are used with highly cross-linked or enhanced polyethylene liners likely explains their popularity. The relative percentage of 28, 32, 36, and > 36mm heads used year-to-year has not changed significantly between 2012 and 2015 (p=.46).

**Figure 20: Femoral Head Sizes Implanted by Year (N=142,700)**

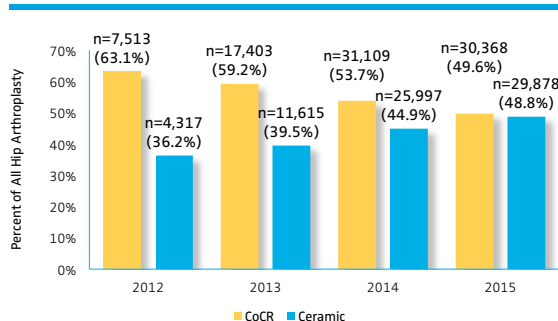


\*Excludes hemiarthroplasty

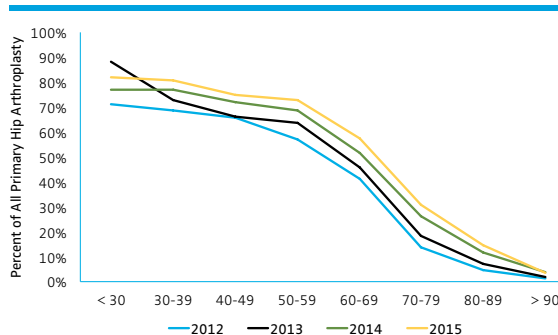


Ceramic head usage has continued to grow each year, and in our sample of U.S. experience, that growth has been both steady and significant between 2012 and 2015 ( $p < .001$ ) (Figure 21). Factors that may have contributed to this growth include the use of ceramic heads as an alternative to metal-on-metal articulations, favorable wear characteristics, and concerns regarding trunnionosis/corrosion with cobalt chrome (CoCr) heads<sup>9,10</sup>. These same factors likely play a role in the overall bias of ceramic head usage in younger patients, as does perhaps the cost/value proposition for patients in the later decades of life (Figure 22). Our sample reflects a greater percentage of CoCr heads used in patients in the later decades of life, with the “tipping point” from an even distribution between ceramic and CoCr heads occurring at age 66. The distribution of ceramic heads among popular head sizes likely reflects overall usage (and perhaps CoCr corrosion concerns) among the larger sizes, and decreased neck length options in 28mm ceramic heads (Figure 23).

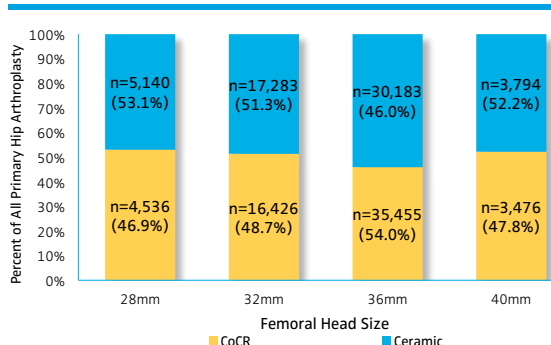
**Figure 21: Composition of Femoral Heads (N=158,200)**



**Figure 22: Ceramic Femoral Head Usage by Patient Decade of Life (N=71,805)**

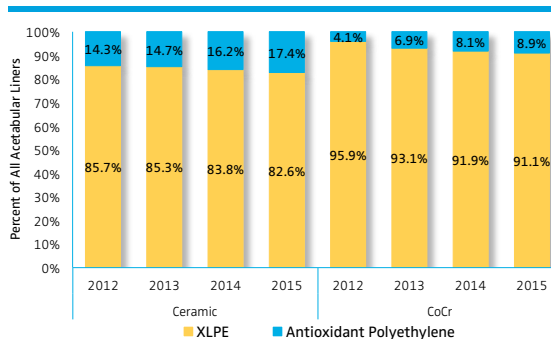


**Figure 23: Composition of Femoral Heads in Primary Hip Arthroplasty by Size (N=116,293)**

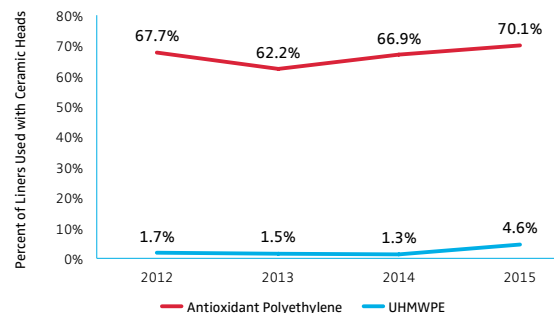


Regardless of whether they use a ceramic head or a CoCr head, the surgeons in our sample overwhelmingly choose to use highly cross-linked polyethylene liners (XLPE) (Figure 24). When antioxidant or “enhanced” liners are chosen, ceramic heads are favored the majority of the time and when conventional polyethylene (ultra-high molecular weight polyethylene—UHMWPE) liners are chosen CoCr heads are typically chosen (Figure 25). Again, this likely represents a value proposition for the patient populations where these combinations are most commonly chosen. However, there is a trend toward increased antioxidant liner use between 2012-2015 in our sample ( $p < 0.001$ ), regardless of head material chosen.

**Figure 24: Percentage of Cobalt Chrome and Ceramic Heads Used with Cross Linked Polyethylene and Antioxidant Polyethylene Acetabular Liners (N=160,505)**

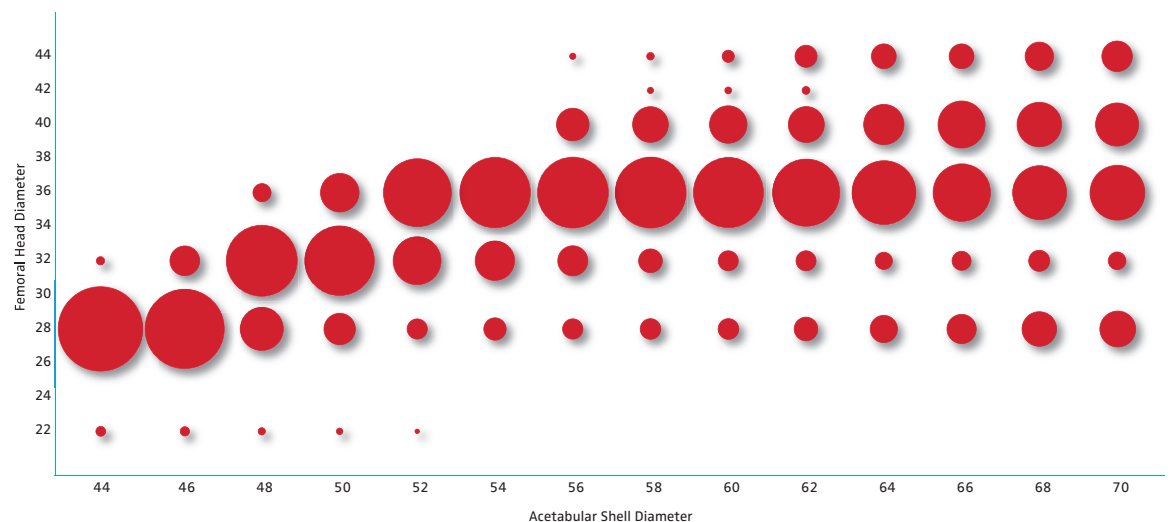


**Figure 25: Alternative Liner Use with Ceramic Heads (N=71,807)**

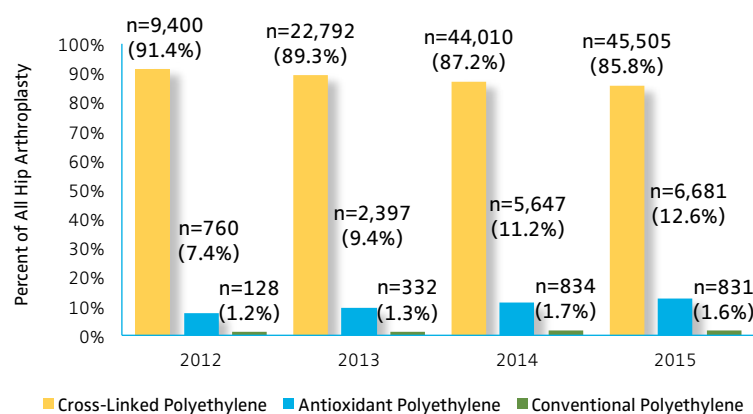


Since both shell diameter and corresponding liner thickness play a role in the surgeon's decision, it is not surprising that the most common head size (36mm) is chosen once that option is available in most contemporary THA systems (52-54mm acetabular diameters) (Figure 26). Similarly, even larger heads (40mm and greater) are chosen with more frequency once the acetabular diameter and liner thickness permit their use (typically 60mm and larger).

**Figure 26: Femoral Head/Acetabular Shell Diameter Combination Frequency (N=120,861)**



**Figure 27: Polyethylene Usage in Acetabular Liners (N=139,317)**

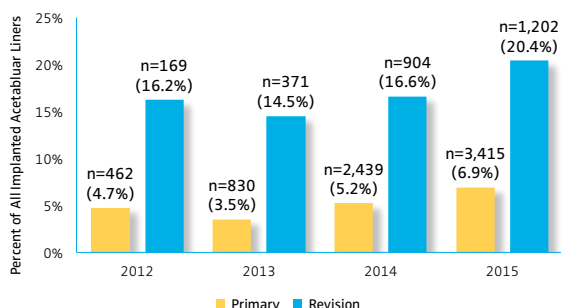


As an example, at an acetabular shell diameter of 56mm, a negligible percentage of heads used are less than 28mm or greater than 40mm, 6% are 28mm, 12% are 32mm, 68% are 36mm, and 14% are 40mm.

Use of either highly cross-linked or antioxidant enhanced (vitamin E impregnated) polyethylene now accounts for the majority of hip arthroplasty procedures in the United States (Figure 27). Most manufacturers offer fewer options in conventional polyethylene in 2015 in response to the availability of longer-term data on the effectiveness of cross-linked polyethylene in reducing clinically evident wear and osteolysis<sup>11-14</sup>.

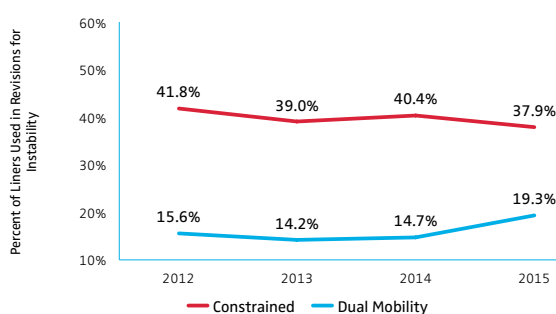
Dual mobility articulations continue to gain interest in the United States, presumably due to the claims of enhanced hip stability and reduced risk of dislocation they provide<sup>15-18</sup>. In this Registry cohort sample of the U.S. experience, dual mobility cups were utilized in approximately 7% of all primary hip arthroplasties and over 20% of revision THA procedures in 2015 (Figure 28).

**Figure 28: Frequency and Percentage of Dual Mobility Cups Implanted by Year (N=9,792)**

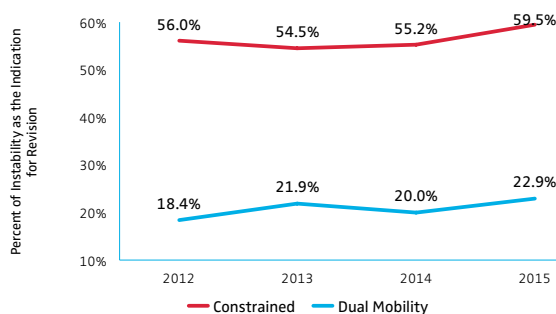


In contrast, constrained liner use remains relatively flat, varying between 1.1 to 1.3% of all liners used in our sample between 2012 and 2015 (data not shown). Since both of these acetabular articulations are often used in a revision setting where instability (or the potential for instability) exists, the use of dual mobility liners when a revision was done for instability/dislocation was analyzed (Figure 29a), and as a corollary, how frequently instability/dislocation was the indication for surgery when a dual mobility liner was used in a revision THA procedure (Figure 29b). Similarly, constrained liners were analyzed in the same fashion. Taking 2015 as an example, dual mobility liners were used in n=159 (19.3%) of the cases where the indication for revision was instability or dislocation and constrained liners were used in n=312 (37.9%) of such cases. Conversely, when a dual mobility cup was used in a revision setting, the diagnosis was instability or dislocation only n=159 (22.9%) of the time, implying that this articulation may be chosen for its perceived benefits for a significant majority of primary revision indications beyond instability. However, when constrained liners are used, the majority of the time n=312 (59.5%) the underlying diagnosis is instability. Presumably surgeons may make an intraoperative decision to use these devices to achieve a more stable construct even when the underlying diagnosis is not instability.

**Figure 29a: Use of Constrained Liners and Dual Mobility Cups for the Surgical Indication of Instability/Dislocation**

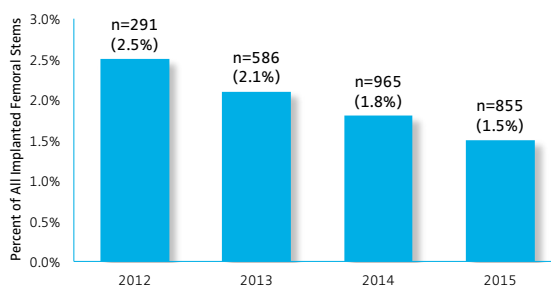


**Figure 29b: Surgical Indication When Using Dual Mobility or Constrained Liners**



Upon their introduction, modular neck stems were seen as having the advantage of increased intraoperative flexibility to adjust offset and neck version during primary arthroplasty, as well as potentially easier insertion through less invasive approaches to the hip. However, reports of breakage and corrosion concerns at this additional modular interface have surfaced, and their use has declined in this registry sample between 2012 and 2015 (p=0.0002) (Figure 30)<sup>19-22</sup>.

**Figure 30: Frequency of Modular Neck Stems Implanted by Year (N=2,697)**

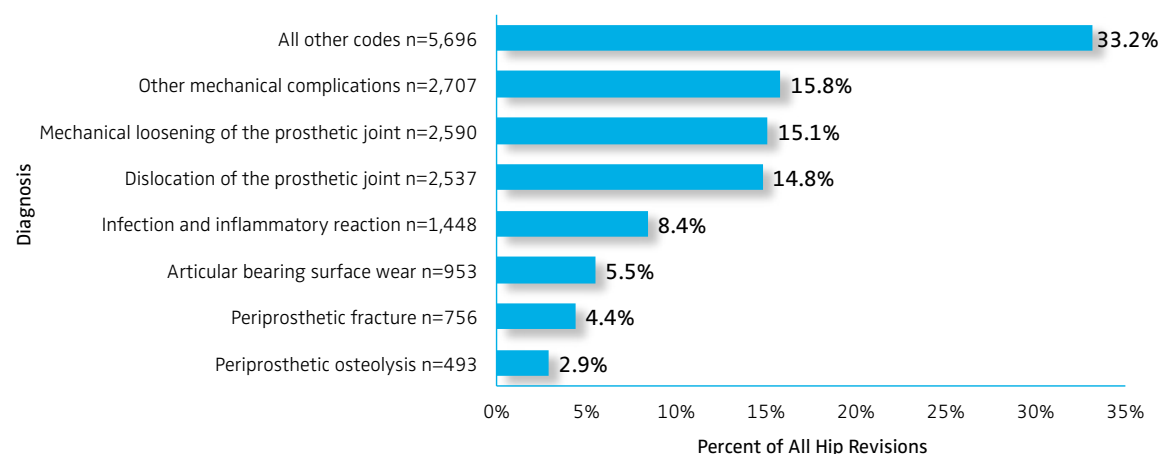


# Revision Data: Hips

Between 2012 and 2015, data were collected on 17,180 revision hip arthroplasties. Of these, 1,640 (9.5%) were “linked revision arthroplasties” where data on the earlier primary THA were also available in the Registry for analysis. Overall, in the larger cohort of 17,180 revision procedures, the predominant cause for revision by diagnosis code was aseptic mechanical, with the four codes for mechanical loosening, other mechanical, wear, and osteolysis (the last two which often co-exist and are interrelated) accounting

together for 39.3% of revisions recorded (Figure 31). Dislocation was the next most common diagnosis, accounting for 14.8%, with infection (8.4%) and periprosthetic fracture (4.4%) less common. The large percentage in “other codes” includes ICD-9 code 998 for “other complications not otherwise classified” and those revisions that were either not coded or miscoded.

**Figure 31: ICD Diagnosis Codes for All Hip Revisions (N=17,180)**



In the 1,640 linked hip arthroplasty revisions where data were also available on the original primary THA, over 68% occurred within the first three months post-surgery (Table 3). This may be due to the relatively short period of data collection for this Registry from many of AJRR's participating hospitals. However, it should also be noted that early revisions have a greater likelihood of returning to the original treating institution (by definition an AJRR reporting hospital) compared to late revision cases that may be more often cared for at a different hospital, which may or may not be reporting to AJRR. In fact, 97% of early hip revisions and 94% of TKA revisions returned to the same hospital or hospital system where the primary

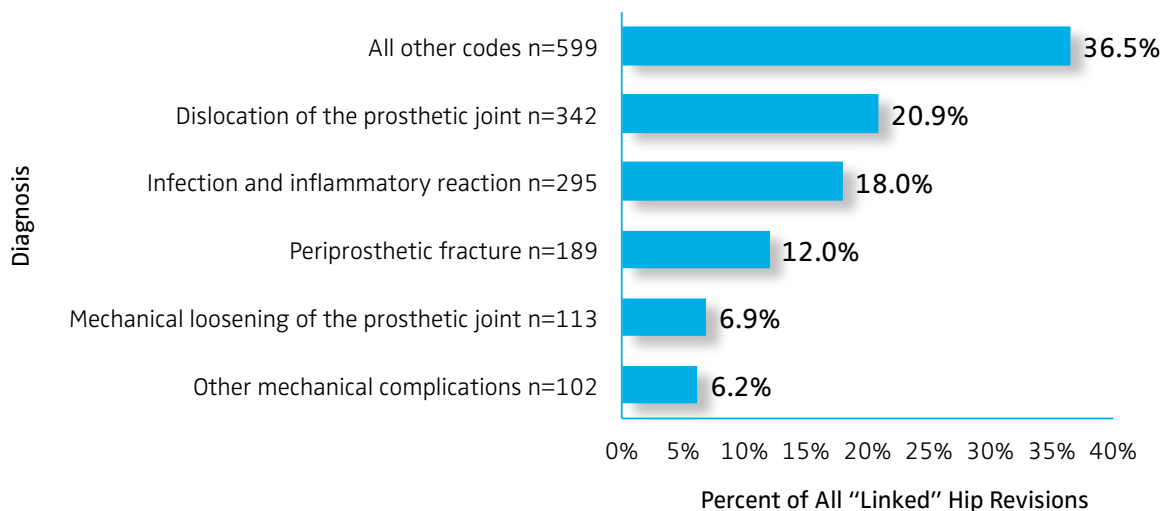
procedure was performed. Fewer than 9% of these linked procedures were revisions performed over one year after primary arthroplasty.

Therefore, the diagnoses that account for revision in this linked subset are clearly biased toward early causes of revision arthroplasty, which often are more related to patient comorbidities and surgical technique than implant performance. Indeed, dislocation is the leading cause of failure in these largely early revisions, accounting for nearly 21%, and it is closely followed by infection in 18%, and periprosthetic fracture in 11.5% (Figure 32). As would be expected, these numbers are even higher when the cohort that is less than three months from surgery is analyzed (Figure 33).

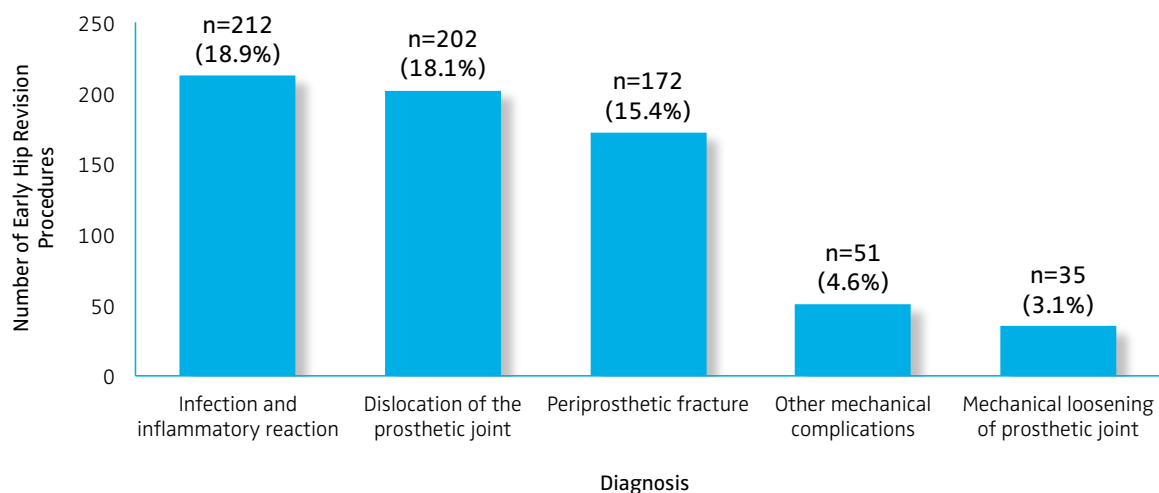
**Table 3: Time Interval between Primary Hip and Revision for “Linked” Patients (N=1,640)**

| <3 Months | 3-6 Months | 6-12 Months | >1 Year |
|-----------|------------|-------------|---------|
| 1,119     | 210        | 167         | 144     |

**Figure 32: ICD Diagnosis Codes for “Linked” Hip Revisions (N=1,640)**



**Figure 33: Most Frequently Reported Diagnosis Codes for Hip Revisions (<3 Months to Revision)**



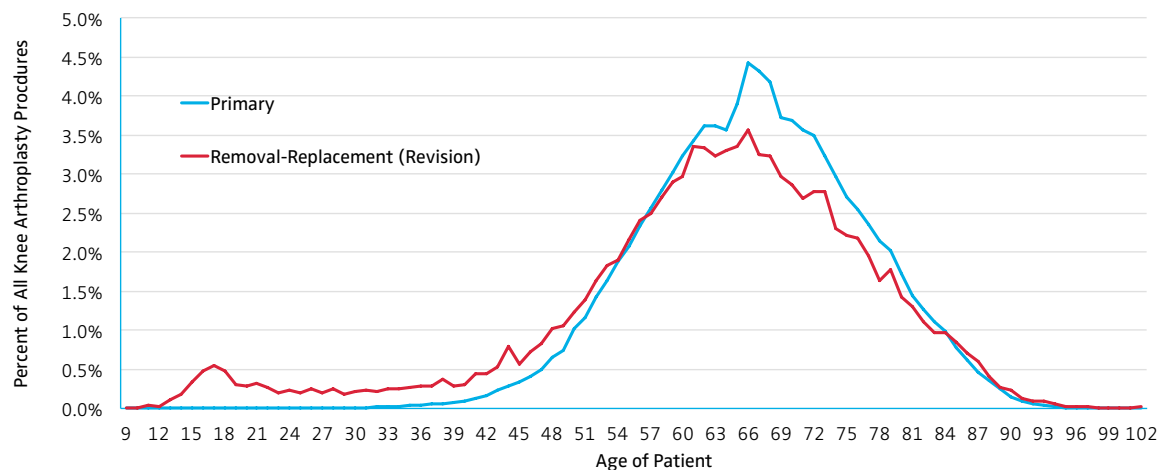


# Knee Arthroplasty

## Procedural Data: Knees

As with hip arthroplasty, in knee arthroplasty, there is a significant difference in the average ages between primary and revision patients ( $p$ -value  $<0.001$ ). The mean age of patients having primary knee arthroplasty was 66.4 (SD 9.8), similar to the total hip population in our sample (Figure 34), but the mean age for the revision knee population is nearly five years younger at 61.8 (SD 15.4). Between the years 2012 and 2015, there was no significant trend toward a younger or older population for TKA procedures among our contributing hospitals.

**Figure 34: Age Distribution of Knee Arthroplasty Procedures (N=258,121)**

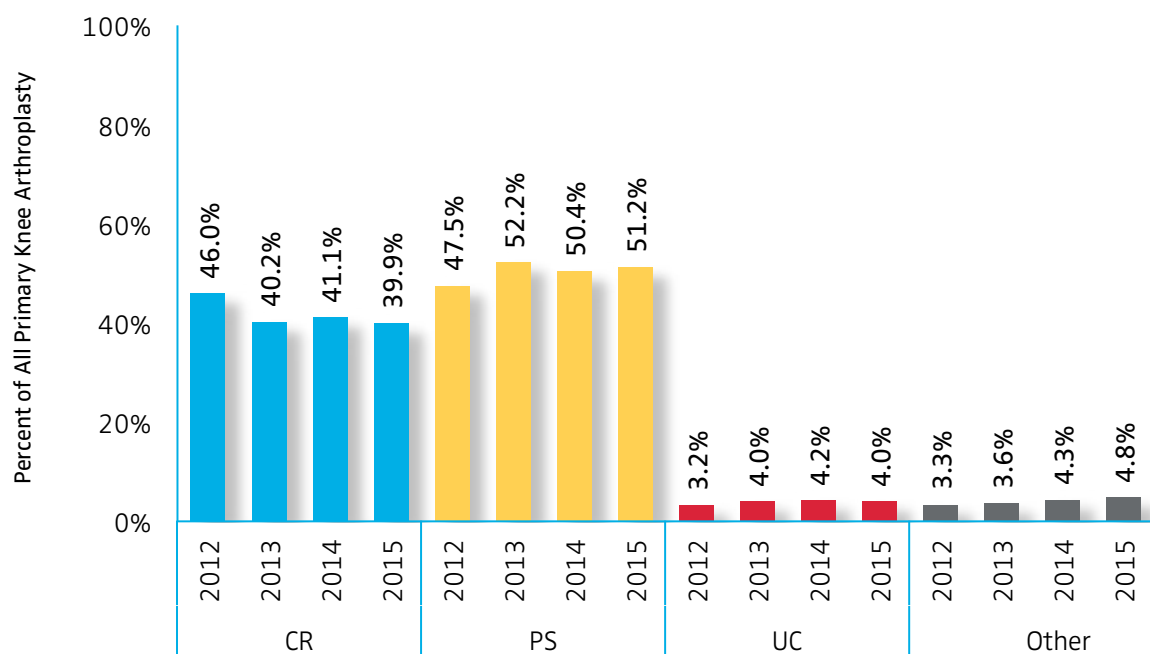


Osteoarthritis was the underlying or original diagnosis for 87% of knee arthroplasties, with rheumatoid arthritis accounting for a fraction of one percent of all arthroplasties performed (similar to the pattern in hip arthroplasty). Revision procedures accounted for 8.7%

of knee arthroplasties performed overall, with the rest primary arthroplasties of some type (data not shown) (See Appendices D and F for procedure and diagnosis codes).

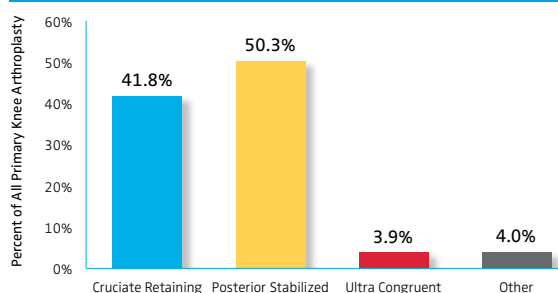
Posterior stabilized type implants continue to be the most common design used in primary knee arthroplasty procedures in this sample accounting for approximately 50% over the three-year span (Figures 35 and 36). Cruciate retaining-type designs were the next most common and made up nearly 42% of the total over the same time frame. Ultracongruent designs, varus/valgus constrained designs, and rotating hinge designs account for the remainder.

**Figure 35: Knee Implant Design by Year (N=207,535)**

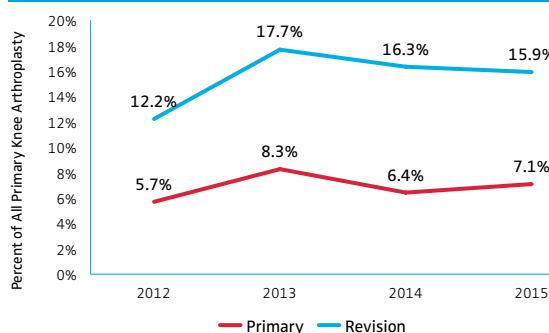


CR: Cruciate Retaining; PS: Posterior Stabilized; UC: Ultra Congruent

**Figure 36: Tricompartmental Knee Implant Design (Cumulative) (N=207,535)**



**Figure 37: Mobile Bearing Designs as a Percentage of All Knee Arthroplasty (N=17,578)**



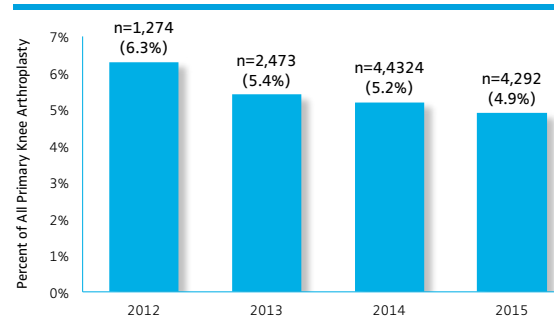
Mobile-bearing designs remain a relatively low, but constant, percentage of TKAs implanted in this sample at almost 7% of the cumulative total TKA population between 2012 and 2015 (Figure 37). Their penetration is higher in revision TKA arthroplasty

(16% of the cumulative total) where some surgeons may perceive benefits to increased rotational freedom and their use with increasing constraint.

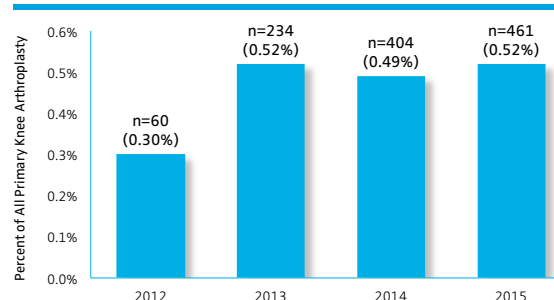
Unicompartmental knee arthroplasties accounted for 5.6% of all primary knee arthroplasties performed in our sample between 2012 and 2015. There has been a slight downward trend ( $p=0.02$ ) in their use between 2012 and 2015 (Figure 38). The AOANJRR has reported UKA usage decreased from 14.5% of all knee arthroplasty performed in 2003 to 4.2% in 2014, while the Swedish Knee Arthroplasty Register (SKAR) reported UKA represented 4% of their knee arthroplasty procedures in 2014<sup>7,23</sup>.

Similarly, patellofemoral arthroplasty remains an even smaller percentage of single compartment arthroplasty in this sample, consistently utilized in less than 1% of knee arthroplasty procedures between 2012 and 2015 (Figure 39). While unicompartmental procedures were performed at a majority of hospitals participating in AJRR during the three years under review, only roughly 30% of surgeons reported to AJRR that they performed unicompartmental procedures during the same year (Table 4). Relatively few surgeons perform patellofemoral arthroplasty, with only between 7 and 9% of all surgeons submitting procedures during the years in question.

**Figure 38: Unicompartmental Knee Arthroplasty as a Percentage of All Primary Knee Arthroplasty (N=12,363)**



**Figure 39: Patellofemoral Arthroplasty as a Percentage of All Primary Knee Arthroplasty (N=1,159)**



Polyethylene inserts were categorized as conventional polyethylene (UHMWPE), cross-linked polyethylene, or vitamin E impregnated/antioxidant polyethylene. Although antioxidant polyethylene is also cross-linked, for the purposes of this analysis it has been treated as a separate category to better identify usage trends. For primary knee arthroplasty procedures performed from 2012 to 2015, usage rates of conventional polyethylene and cross-linked polyethylene declined slightly (all  $p<0.02$ ), balanced by a steady increase in the use of antioxidant polyethylene ( $p=0.01$ ) over the same time frame from 2% in 2012 to nearly 25% by 2014.

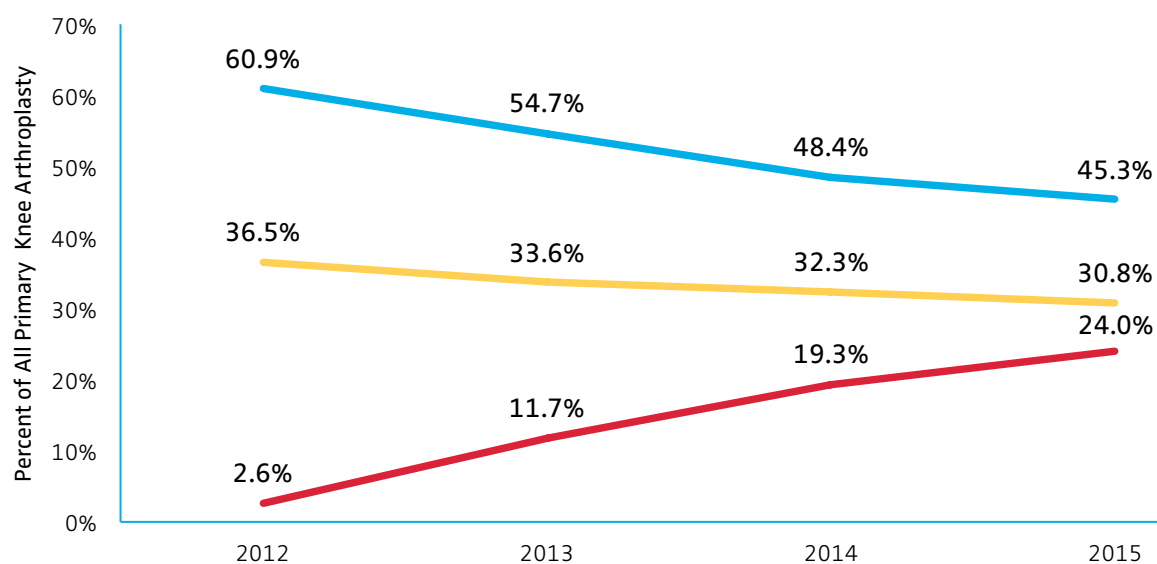
In contrast, polyethylene usage in revision knee arthroplasty involved conventional polyethylene in more than 50% of revision procedures overall. Slightly more than one third of revision TKA patients received cross-linked polyethylene; while cross-linked polyethylene and conventional polyethylene usage has remained relatively steady ( $p=0.13$  and  $0.83$ , respectively) between 2012 and 2015, there has been an increase in the use of antioxidant polyethylene ( $p=0.004$ ) (Figures 40a and 40b).

**Table 4: Unicompartmental Knee Arthroplasty and Patellofemoral Arthroplasty Utilization**

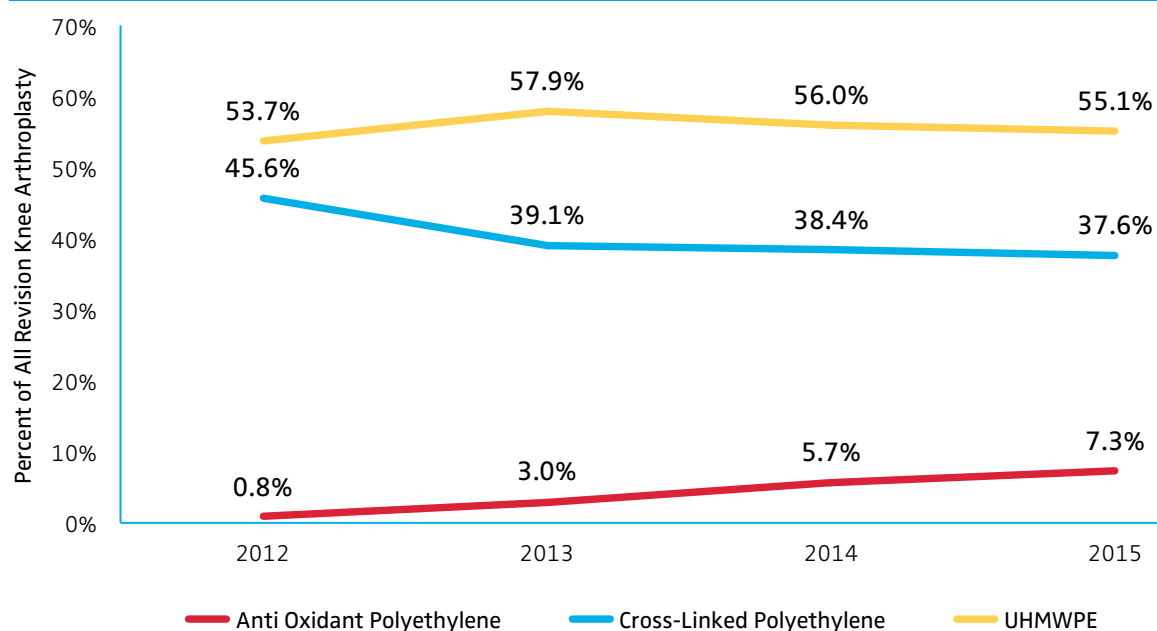
|  | 2012<br>n (%)  | 2013<br>n (%)  | 2014<br>n (%)  | 2015<br>n (%)  |
|--|----------------|----------------|----------------|----------------|
| Surgeons performing unicompartmental knee arthroplasty | 151<br>(27.6%) | 363<br>(30.2%) | 591<br>(32.1%) | 682<br>(30.4%) |
| Surgeons performing patellofemoral arthroplasty        | 39<br>(7.1%)   | 93<br>(7.7%)   | 159<br>(8.6%)  | 190<br>(8.5%)  |
| Total number of surgeons submitting TKA                | 547            | 1,203          | 1,840          | 2,240          |

Patellar replacement remains the predominant practice in North America in contrast to Scandinavia and Australia. This is evident in our sample data, with over 84% of patients receiving a patellar component each year, while resurfacing occurred in 59.3% of primary arthroplasty in Australia and only 2.2% of the procedures performed in Sweden <sup>7,23</sup> (Figure 41).

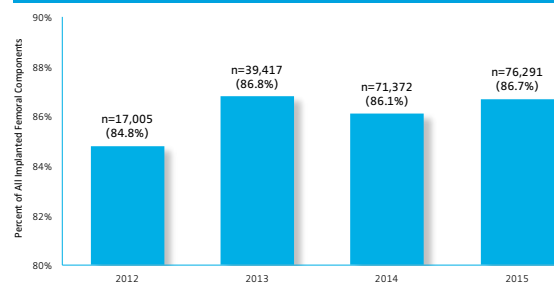
**Figure 40a: Percentage of Polyethylene Usage by Year in Total Knee Arthroplasty (N=232,582)**



**Figure 40b: Percentage of Polyethylene Usage by Year in Total Knee Arthroplasty (N=232,582)**



**Figure 41: Percentage of Knee Arthroplasty with Patellar Resurfacing (N=204,085)**



## Revision Data: Knees

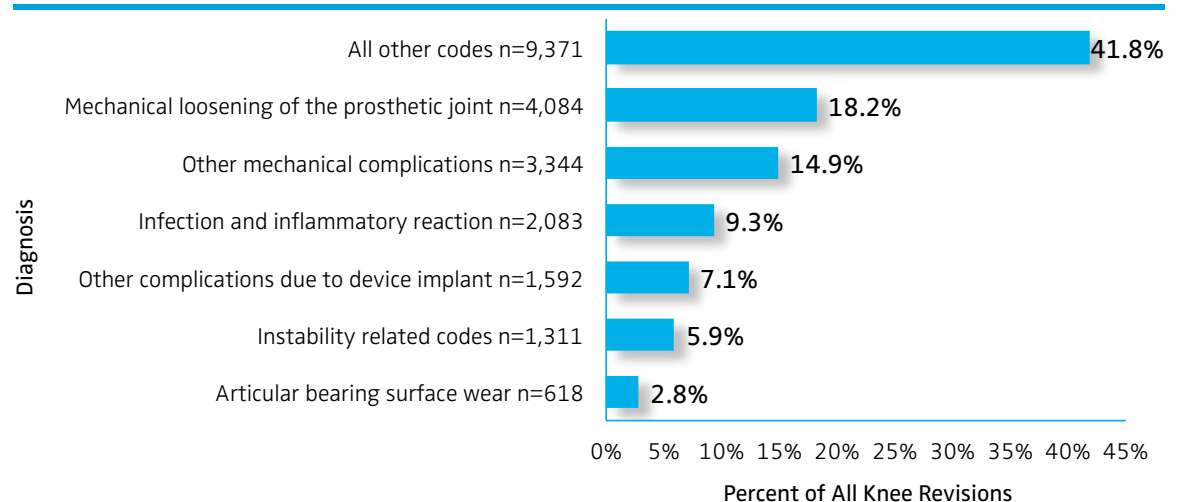
The main cause of revision as indicated by diagnosis codes were aseptic loosening, wear, or mechanical causes of failure in the majority of over 22,000 procedures collected, with infection accounting for 9.3% overall (Figure 42). A total of 1,276 of these revisions were “linked” procedures, which had data in the Registry relating to the original primary procedure as well. Of these linked revision procedures, 34% were performed in the first three months post-surgery and 28% were

performed more than a year after the primary procedure (Table 5). In keeping with this bias toward early revision procedures, aseptic problems of wear, or mechanical failure, were less frequent than infection, which accounted for more than one in four of these relatively early revision procedures (Figures 43 and 44).

**Table 5: Time Interval between Primary Knee and Revision for “Linked” Patients (N=1,276)**

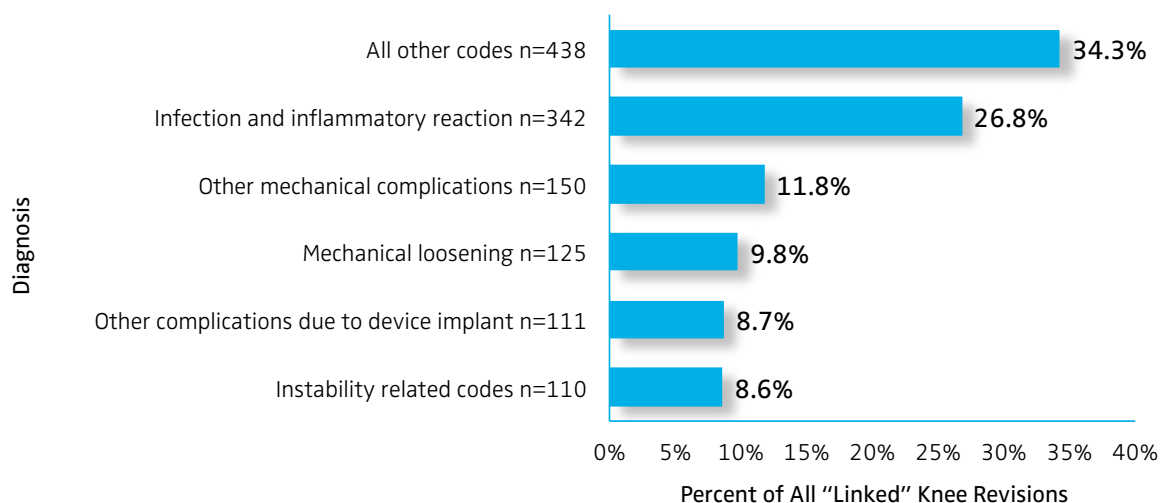
| <3 Months | 3-6 Months | 6-12 Months | >1 Year |
|-----------|------------|-------------|---------|
| 433       | 190        | 299         | 154     |

**Figure 42: ICD Diagnosis Codes for Knee Revisions (N=22,403)**

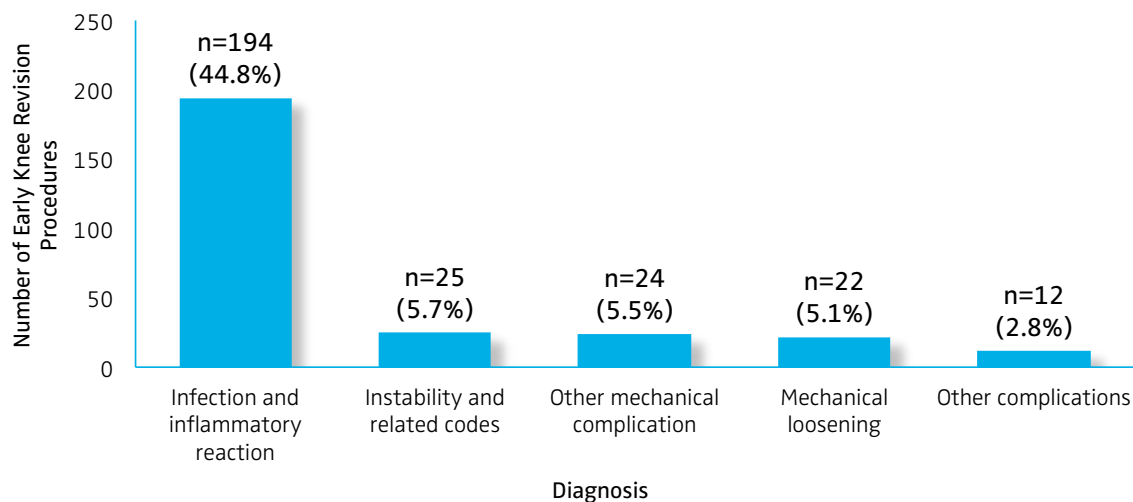




**Figure 43: ICD Diagnosis Codes for All “Linked” Knee Revisions (N=1,276)**



**Figure 44: Most Frequently Reported ICD Diagnosis Codes for Early Knee Revisions (<3 Months to Revision) (N=433)**



# Level II and III Update and Data Reporting

In 2014, AJRR conducted a pilot program identifying automated methods to acquire Level II data and to test the features implemented to manage the Level III/PROs process (Appendix B). It was determined that if data elements were a discrete field in the hospital EHR, said data could easily be extracted and submitted to AJRR. As such, AJRR determined that comorbidities and American Society of Anesthesiologists (ASA) classifications were easily included. However, AJRR decided not to include lab values and prophylaxis as part of Level II reporting.

In 2015, AJRR convened a Risk Adjustment Task Force to review findings from the Level II pilot program

and develop a list of elements to be included in the subsequent Level II platform. Prior to AJRR finalizing these comorbidity elements needed for risk adjustment, CMS released in July 2015 a proposed rule for the Comprehensive Care for Joint Replacement (CJR) model. This model tests bundled payment and quality measurement for an episode of care associated with hip and knee replacement. The proposed rule included a number of suggestions for risk variables to be submitted by hospitals as a part of their reporting. As a result, AJRR did not finalize intentions for the Level II data elements after the CJR Final Rule was released on November 16, 2015.

## Programming and Funding

As AJRR became an independent, self-sustaining organization in 2015, a revised business plan was critical to future success. During the first half of 2015, AJRR revised its initial business plan and developed a three-year plan that identifies revenue and expense targets. As such, AJRR has been able to decrease the original sponsors' financial obligations. A significant revenue stream comes from the sale of hospital licenses and AJRR's participation as a subcontractor for federal initiatives.

### **Collaboration with Medical Device Manufacturers**

Throughout 2015, AJRR maintained ongoing dialogue with medical device manufacturers pertaining to their ability to access specific device data. AJRR is currently making the necessary program changes to be able to provide industry with access to a real-time, online portal where the manufacturers can have access to anonymized, patient-level validated data sets for their products. The industry's working group plays a significant role in designing and implementing standards that will allow industry this access. The target date for rollout is the end of December 2016. Additionally, AdvaMed was instrumental in providing input and direction to AJRR's strategic plan and provided help to scale and move the funding model to that of hospital subscriptions. They continue to offer leadership on the Board of Directors and are instrumental in providing the guidance and direction toward long-term sustainability.

# Strategic Alliances and Affiliations

## **PCPI®**

PCPI® is a membership organization uniquely focused on improving patient health and safety through the advancement of measurement science, quality improvement, and clinical registries. In 2015, the National Quality Registry Network (NQRN®) became a key component of PCPI's registry program. NQRN is a voluntary network consisting primarily of PCPI member organizations interested in clinical registries.

Throughout 2015, NQRN continued to be the national force for moving the clinical registry enterprise forward. The network provided education and tools for registry organizations, including a technical report on HIPPA and the Common Rule, new educational collateral for registries, a public preview version of its registry maturational framework, and a guide to using registries for CMS quality measures submission under PQRS as QCDRs. AJRR achieved QCDR status in 2014. NQRN hosts an annual meeting; discussion at the 2015 gathering centered around building the next generation of clinical registries. Panel discussions were held on the many uses of information from clinical registries, and on public reporting of performance results powered by registry data. Finally, AJRR Director of Marketing and Communications Lori Boukas serves on the NQRN Communications Committee while Director of Analytics Caryn Etkin is a member of NQRN's Leading Practices Committee.

## **Commercial Health Plans**

The 2015 AJRR Board of Directors included two members who represented the commercial health plan community (Mr. Krebbs and Dr. Mino). Robert L. Krebbs is Director of Payment Innovation, Anthem, Inc. David E. Mino, MD, MBA, is with Cigna Healthcare as Senior Medical Director and National Medical Director, Orthopaedic Surgery and Spinal Disorders. Dr. Mino also served on the AJRR Board of Directors and Executive Committee as Secretary/Treasurer.

## **The Joint Commission**

AJRR continued efforts that began in 2012, by establishing productive discussions with The Joint Commission that were focused on recognizing hospitals that submitted data to AJRR. The AJRR Public Advisory Board membership includes a representative from The Joint Commission (Ms. Margaret VanAmringe), and continues to have an active collaborative relationship with The Joint Commission on a variety of topics including their Orthopaedic Joint Replacement certification process and making registry participation a key component.

## **The Pew Charitable Trusts**

AJRR continues to dialogue with the Pew Charitable Trusts about the FDA's UDI system requirements and the FDA's regulation regarding UDI. AJRR's Medical Director David Lewallen, MD has represented AJRR at numerous sessions to discuss the roll out and how it affects AJRR's ability to capture UDI as a data element.

## **Physician Clinical Registry Coalition**

This coalition is a group of 23 medical society-sponsored or physician-led clinical data registries working together to advocate for public policy changes that will promote the development of registries and strive to remove barriers to the registries. AJRR Executive Director Jeffrey Knezovich and AJRR Government Relations Specialist Judi Buckalew are active members of the coalition.

## **Government, Advocacy, and Public Affairs**

On February 5, 2015, the "Expanding the Availability of Medicare Data Act," (H.R. 804) was introduced to amend title XVIII of the Social Security Act to increase access to Medicare data.

The "Protecting the Integrity of Medicare Act," (H.R. 1021) was passed on February 26, 2015. This act contained legislative language requested by AJRR that directs the Health and Human Services' Office of Human Research Protections (OHRP) to issue a guidance clarifying the applicability of the Common Rule to clinical data registries. On September 8, 2015, OHRP released a Notice of Proposed Rule Making in the Federal Register asking for input on the proposed rule to modernize, strengthen, and make more effective the Federal Policy for the Protection of Human Subjects, otherwise known as the Common Rule. AJRR submitted a comment letter on January 6, 2016.

Second quarter 2015 introduced the "SGR Repeal and Medicare Provider Payment Modernization Act," (H.R. 1470). On March 25, 2015, the "Medicare Access and CHIP Reauthorization Act" (MACRA) (H.R. 2) was passed and it replaced the "SGR Repeal and Medicare Provider Payment Modernization Act." MACRA repealed the flawed Medicare Sustainable Growth Rate (SGR) physician payment formula and replaced it with a value-driven payment system. On July 6, 2015, CMS announced CJR, a new Medicare payment model for hip and knee replacement procedures performed in hospital inpatient settings. AJRR submitted a comment letter to CMS on September 8, 2015. In addition, on November 16, 2015, CMS issued a final rule covering modifications to Stages 1 and 2; the 2015 edition of electronic health records certification criteria; and Stage 3 of Meaningful Use. AJRR submitted a comment letter to CMS on December 15, 2015.

**Additional government-related activities and initiatives are described below.**

**Agency for Healthcare Research and Quality (AHRQ)**

Launched on December 1, 2012, the Registry of Patient Registries (RoPR), an AHRQ initiative, provides a searchable database of existing patient registries in the United States. AJRR is an official enrollee in RoPR and the information can also be found at [www.ClinicalTrials.gov](http://www.ClinicalTrials.gov), a repository and results database of publicly and privately supported clinical studies of human participants conducted around the world.

**Centers for Medicare & Medicaid Services (CMS)**

At the conclusion of 2012, Congress enacted legislation to establish the QCDR program. The QCDR initiative was designed to be an additional pathway for eligible professionals to participate in PQRS. AJRR followed the development of the QCDR program throughout 2013, had planning meetings, and responded to the proposed QCDR rules. AJRR was selected by CMS to be a QCDR in both 2014 and 2015.

AJRR partnered with CECity, a leading provider of cloud-based registry platforms for performance improvement and value-based payment, to create the custom platform for data submission to CMS. By partnering with CECity for the Orthopaedic Quality Resource Center, AJRR has the ability to fully implement the QCDR program requirements. The CECity platform ensures that eligible professionals meet all of the data, scoring, and attestation requirements before they submit their PQRS reports to CMS for payment. Additionally, this platform was used for individual physicians to meet their Meaningful Use requirements.

As discussed above, CMS introduced the CJR payment model to be tested in select metropolitan areas across the United States. AJRR followed the development of the program throughout the summer and fall of 2015. The CJR Final Rule was released on November 16, 2015. AJRR continues to make modifications to its platform to help ensure that institutions that are mandated to participate in this program can utilize Registry participation to meet their requirements.

AJRR also continues to work with The Knee Society, The Hip Society, and AAHKS on performance measures being developed and approved for CMS's PQRS initiative. These measures, as they become approved and available, will be part of AJRR's QCDR quality data set that surgeons will use to qualify for additional payment and/or avoid penalties under PQRS.

**Food and Drug Administration (FDA): Center for Devices and Radiological Health (CDRH)**

In 2007, a law was signed to establish a UDI system that required: (a) the label of a device to bear a unique identifier; (b) the unique identifier to identify the device through distribution and use; and (c) the unique identifier to include the lot or serial number if specified by the FDA. On September 20, 2014, the FDA announced a final rule for the UDI system. AJRR prepared comments regarding the appropriateness of UDI collection for a registry. AJRR's comments were well received and played a role in the final ruling about when the first package will be identified with UDI. On September 24, 2015, UDI was to be implemented on all Class III devices.

Additionally, in 2014, previous AJRR Board Chair William Maloney, MD was selected to be a member of the National Medical Device Registries Task Force (MDRTF). Throughout 2014 and 2015 the Task Force worked on a document intended to provide recommendations to the FDA pertaining to the development of a national medical device surveillance system to support regulatory decisions and enable stakeholders across medicine. The report, *Recommendations for a National Medical Device Evaluation System*, was released for public comment in August of 2015.

The MDRTF was asked to address the implementation of registries in postmarket surveillance and throughout the total product life cycle. The MDRTF was coordinated through the Medical Device Epidemiology Network (MDEpiNET) Public-Private Partnership initiative (<http://mdepinet.org>), which is part of the CDRH. MDEpiNET is a collaborative program through which CDRH and external partners share information and resources to advance a national and international infrastructure for patient-centered regulatory science, surveillance, and quantitative methods. The initiative outputs will result in optimized evidence generation, appraisal, and synthesis for medical device Total Product Life Cycle evaluation. David Lewallen, MD is a member of the MDEpiNET publications committee.

Finally, FDA awarded a U01 cooperative grant to Weill Cornell Medical College (Dr. Art Sedrakyan, Principal Investigator), in which AJRR is a sub-contractor. *Creating National Surveillance Infrastructure for Priority Medical Devices* cemented a formal partnership with the Functional and Outcomes Research for Comparative Effectiveness in Total Joint Replacement (FORCE-TJR) at the University of Massachusetts, HealthEast Joint Registry, and Kaiser Permanente National Implant Registries to support the development of a national medical device research and surveillance system.

#### **International Consortium of Orthopaedic Registers (ICOR)**

ICOR was established by the FDA and rolled out during a workshop in May 2011 ([www.icor-initiative.org](http://www.icor-initiative.org)). The intent of the workshop was to facilitate discussion among FDA and worldwide orthopaedic registries that have orthopaedic implant information, in order to further collaborate through a research network that pools the collective experience and available data. David Lewallen, MD serves as a member of the ICOR Steering Committee. ICOR continues to work with colleagues from across the United States and other countries on the development and implementation of a worldwide implant database. ICOR has completed analysis of bearings used in hip arthroplasty and fixed and mobile bearings used in knee arthroplasty. Much of the ICOR efforts are now being done in collaboration with the FDA U01 grant mentioned above.

#### **Michigan Arthroplasty Registry Collaborative Quality Initiative (MARCQI)**

AJRR continues to maintain close ties with MARCQI. Collaboration with MARCQI enables rapid recruitment and resultant data acquisition. Twenty-two MARCQI hospitals also participate in AJRR, with data submitted directly on behalf of MARCQI hospitals. AJRR engages in regular dialogue with MARCQI directors and participating hospitals to minimize the burden of data submission and maximize the value of the information collected. MARCQI Co-Directors Drs. Brian Hallstrom and Richard Hughes serve on AJRR's Data Management Committee with Dr. Hallstrom as Chairman of the Data Analysis Workgroup.

#### **International Society of Arthroplasty Registers (ISAR)**

ISAR is a global consortium of joint replacement registries ([www.isarhome.org](http://www.isarhome.org)) established by several of the mature national registries. The society facilitates the development of registry science and observational studies, encourages the development of new national registries around the world, and provides a forum for information sharing to enhance participating countries' ability to meet their own objectives. ISAR also assists in the development of collaborative activities and provides support to both established and developing registries, such as AJRR. AJRR is an active participant and member of ISAR, with podium presentations at the Fourth International Congress of Arthroplasty Registries in Gothenburg, Sweden.

#### **ArthroplastyWatch**

ArthroplastyWatch is a Swedish-based information project developed in 2011 and 2012 ([www.arthroplastywatch.com](http://www.arthroplastywatch.com)) supported by the Swedish government but freely available to the public. The project is intended to collect data on implant recalls or alerts, and arthroplasty safety issues from around the world and from a variety of sources. This information is then disseminated online via a publicly available website. Data are continually collected, updated, and monitored by a team of experts, such as David Lewallen, MD, who is a member of the ArthroplastyWatch Advisory Board.

#### **Operation Walk USA**

Last year marked the fifth annual Operation Walk USA event. In early December 2015, 36 surgeons performed total joint replacements on 68 under- or uninsured individuals at 23 hospitals. Prior to Operation Walk USA, these individuals were unable to receive the care they desperately needed, and many experienced substantial pain and disability. AJRR is proud to be a partner with this organization. AJRR's data collection software houses the basic demographic and procedural data collected on these patients so that the staff and surgeons of Operation Walk USA can track outcomes of these procedures over the coming years. AJRR makes annual contributions to Operation Walk USA to honor the board service of those who have completed their terms.

# Preliminary 2016 Accomplishments

- Increased hospital enrollment to 818
  - New enrollees included large health systems such as Ascension Health, National Surgical Hospitals, Trinity Health, Universal Health Services, and University of Pittsburgh Medical Center
  - Expanded enrollment to include 15 ASCs and 63 private practice groups
  - Participants included 20 of 25 *U.S. News and World Report* Best Hospitals for Orthopaedics
  - 519 hospitals are submitting data, along with 5 ASCs and 5 private practice groups
  - 539,928 total procedures received since inception
  - Over 5,000 surgeons included
- Licensing contracts with institutions reaches \$1 million in revenue
- AJRR is undergoing a complete reorganization of technology capabilities to include new Level I dashboards and reports, Level II data collection, and expanded Level III/PRO and AJRR collection and reporting capabilities, unifying CJRR and AJRR data systems
- Evolved AJRR's relationships with technology vendors and created the Authorized Vendor program
  - AJRR has formal relationships with 20 technology vendors
- Expanded staff to 20
  - Hired AJRR's first Chief Technology Officer, Paul Haisman
  - Created customer service function with three new staff dedicated to servicing participating institutions

## Infrastructure

- Information Technology Department completed a 30-day comprehensive review and assessment of AJRR's platform capacity and capabilities
- AJRR's User Group Network (Unet) Advisory Board convened to help enhance the user's experience and engage with each other about all things Registry related and an online community forum for Unet launched on website





## Quality Initiatives

- Advanced AJRR as a comprehensive quality initiative, focusing efforts beyond being a device Registry
  - The evolution facilitates AJRR's expansion and support of quality programs such as CMS's CJR, MACRA, and MIPS along with other alternative payment models and quality distinction programs for commercial health plans
- Selected by CMS to be a QCDR, one of 69 throughout the United States
  - Collaborated with the American Orthopaedic Association's Own the Bone program to implement two measures focused on post-fracture care and osteoporosis. AAHKS also partnered with AJRR to implement four new custom hip measures to the platform

## Collaborations

- Strengthened collaborative efforts between AJRR and AAHKS
  - AJRR became the official Registry of AAHKS
  - All AAHKS members received a Getting Started Guide packet, and new members receive a packet each month
  - AJRR receives complimentary advertisements in AAHKS publications and website
  - AJRR named Arthroplasty Today, an AAHKS publication, as their official journal. An executive summary of this Annual Report is published in Arthroplasty Today as well as articles using data from AJRR
- Collaborated with the Ambulatory Surgery Center Association (ASCA) and the Accreditation Association for Ambulatory Health Care (AAAHC) facilitating increased participation for ASCs
  - Two presentations to association leadership are planned for fall 2016
- Began an effort to gather data on external prosthetics for individuals with limb loss
  - A pilot study will establish the feasibility of establishing a National Prosthetics Registry designed to support evidence-based decision making; normalize healthcare delivery; establish and disseminate best practices; and adequately standardize, measure, and report outcomes for patients with limb loss
  - Conducted through a partnership with Mayo Clinic, the American Orthotic and Prosthetic Association, and the Thought Leadership and Innovation Foundation
- Received preliminary results from FDA-funded collaboration with MDEpiNet's Science and Infrastructure Center at Weill Cornell Medical College in conducting linkages between AJRR and New York State Statewide Planning and Research Cooperative System (SPARCS) data and Medicare Provider Analysis and Review (MedPAR) data.
  - Preliminary results with SPARCS data have found a 93.2% match for hip procedures and an 87.2% match for knee procedures, and with MedPAR data, 82.6% and 81.3% match rates, respectively
  - Engaged in efforts to identify other sources to conduct linkages with other national data sets

## Increase in Hospital Enrollment 2010-2016

| 2010     | 2011      | 2012       | 2013       | 2014       | 2015       | 2016       |
|----------|-----------|------------|------------|------------|------------|------------|
| <b>6</b> | <b>15</b> | <b>122</b> | <b>242</b> | <b>417</b> | <b>612</b> | <b>818</b> |

# Appendix A 2015 AJRR Committee Members

## Data Management Committee

Bryan D. Springer, MD – Chair  
OrthoCarolina

John W. Barrington, MD  
Orthopaedics and Sports Medicine  
Plano

Craig J. Della Valle, MD  
Midwest Orthopaedics at Rush

Michael P. Dohm, MD  
University of Arizona

Blair Fraser  
Smith & Nephew

Stephen E. Graves, MD  
Australian Orthopaedic  
Association National Joint  
Replacement Registry

Brian R. Hallstrom, MD  
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Richard E. Hughes, PhD  
University of Michigan

Richard L. Ilgen II, MD  
University of Wisconsin

Robert L. Krebs  
Anthem

David G. Lewallen, MD  
Mayo Clinic

Hilal Maradit-Kremers, MD  
Mayo Clinic

David G. Mekemson  
Public Advisory Board  
Representative

Colin Nelson, BA  
Informed Medical Decisions  
Foundation

Pamela L. Plouhar, PhD  
DePuy Synthes

Sarah Shi  
Stryker

Scott M. Sporer, MD  
Midwest Orthopaedics at Rush  
and Central DuPage Hospital

Jing Xie, PhD  
ZimmerBiomet

## Finance and Compensation Committee

David E. Mino, MD, MBA – Chair  
Cigna

John A. Canning, Jr.  
Madison Dearborn Partners, LLC

Michael R. Dayton, MD  
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Gregory B. Krivchenia II, MD  
First Settlement Orthopaedics

Kristen Murtos, MBA  
NorthShore University  
HealthSystem

Brian S. Parsley, MD  
University of Texas Health  
Science Center at Houston and  
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## Regulatory Committee

E. Anthony Rankin, MD – Chair  
Providence Hospital

David A. Halsey, MD  
University of Vermont Medical  
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David G. Lewallen, MD  
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Carolinas Medical Center

Brian S. Parsley, MD  
University of Texas Health  
Science Center at Houston and  
Baylor College of Medicine

Pamela L. Plouhar, PhD  
DePuy Synthes

Margaret VanAmringe, MHS  
The Joint Commission

# Appendix B Core Data Elements

## LEVEL I

### Patient

- Name (Last, First)
- Date of birth
- Social Security Number
- Diagnosis (ICD-9/10)
- Gender
- Ethnicity

### Hospital

- Name
- National Provider Identifier (NPI)
- Address

### Surgeon

- Name
- National Provider Identifier (NPI)

### Procedure

- Type (ICD-9/10)
- Date of surgery
- Laterality
- Implants

## LEVEL II

### Patient comorbidities (ICD-9/10)

- General comorbidities
- Addictions and other mental health comorbidities
- Cardiac-related comorbidities
- Circulatory/Vascular comorbidities
- Charlson and Elixhauser comorbidity indices

### Length of stay

### Body Mass Index

American Society of  
Anesthesiologists (ASA)  
classification

### CJR risk variables

Operative and post-operative  
complications

## LEVEL III

### Harris Hip Score

Hip disability and Osteoarthritis  
Outcome Score (HOOS)

Hip dysfunction and  
Osteoarthritis Outcome Score  
for Joint Replacement  
(HOOS, JR.) \*

Knee injury and Osteoarthritis  
Outcome Score (KOOS)

Knee injury and Osteoarthritis  
Outcome Score for Joint  
Replacement (KOOS, JR.) \*

Knee Society Knee Scoring  
System

Medical Outcomes Study 36-  
Item Short Form Health Survey  
(SF-36)

Oxford Hip and Knee Scores

Patient-Reported Outcomes  
Measurement Information  
System (PROMIS) 10-item  
Global Health \*

Veterans Rand 12-Item Health  
Survey (VR-12) \*

Western Ontario and McMaster  
Universities Arthritis Index  
(WOMAC)

\* Recommended

# Appendix C

## 2012-2015 Participating Hospitals, Health Systems, Private Practice Groups, and ASCs

\* Institutions that Submitted Data for this Annual Report

### ALABAMA

Cullman Regional Medical Center\*  
Huntsville Hospital\*  
Jack Hughston Memorial Hospital\*

### ALASKA

Alpine Surgery Center\*  
Central Peninsula Hospital\*  
Providence Alaska Medical Center\*  
Providence Kodiak Island Medical Center\*

### ARIZONA

Arizona Spine & Joint Hospital  
Banner - University Medical Center South\*  
Banner University Medical Center Tucson Campus\*  
Carondelet St. Joseph's Hospital\*  
Chandler Regional Medical Center  
Flagstaff Medical Center\*  
Mercy Gilbert Medical Center  
Mountain Vista Medical Center  
Northwest Medical Center\*  
Oasis Health\*  
St. Luke's Medical Center  
Tempe St. Luke's Hospital  
Verde Valley Medical Center\*

### ARKANSAS

CHI St. Vincent\*  
Mercy Hospital Fort Smith  
Mercy Hospital of Northwest Arkansas  
Mercy Orthopedic Hospital Fort Smith  
National Park Medical Center  
University of Arkansas for Medical Sciences

### CALIFORNIA

Adventist Medical Center - Hanford\*  
California Pacific Medical Center  
Clovis Community Medical Center  
Community Hospital of Monterey Peninsula\*  
Corona Regional Medical Center  
Dameron Hospital  
Desert Regional Medical Center  
Doctors Medical Center  
Eisenhower Medical Center  
El Camino Hospital, Los Gatos Campus

El Camino Hospital, Mountain View Campus  
Feather River Hospital\*  
Fresno Surgical Hospital  
Glendale Adventist Medical Center\*  
Henry Mayo Newhall Hospital  
Hoag Orthopedic Institute  
Howard Memorial Hospital\*  
Huntington Hospital\*  
Inland Valley Medical Center  
John Muir Medical Center - Concord  
John Muir Medical Center - Walnut Creek  
Keck Medical Center of USC\*  
Lodi Memorial Hospital  
Long Beach Memorial\*  
Memorial Medical Center  
Mercy General Hospital  
Mercy Hospital of Folsom  
Mercy San Juan Medical Center  
Methodist Hospital of Sacramento  
Monterey Peninsula Surgery Center  
NorthBay Medical Center  
NorthBay VacaValley Hospital\*  
Orange Coast Memorial\*  
Palmdale Regional Medical Center  
Palomar Medical Center  
PIH Health Hospital - Whittier  
Pomerado Hospital  
Pomona Valley Hospital Medical Center\*  
Presidio Surgery Center\*  
Providence Holy Cross Medical Center\*  
Providence Little Company of Mary San Pedro\*  
Providence Little Company of Mary Torrance\*  
Providence Saint John's Health Center\*  
Providence Saint Joseph Medical Center\*  
Providence Tarzana Medical Center\*  
Rancho Springs Medical Center  
Ronald Reagan UCLA Medical Center\*  
Saddleback Memorial\*  
Salinas Valley Memorial Healthcare System  
San Antonio Regional Hospital\*  
San Joaquin Community Hospital\*

Scripps Green Hospital  
Sharp Chula Vista Medical Center  
Sharp Coronado Hospital  
Sharp Grossmont Hospital  
Sharp Memorial Hospital  
Shasta Regional Medical Center\*  
Simi Valley Hospital\*  
Sonoma Valley Hospital  
Sonora Regional Medical Center\*  
St. Agnes Medical Center  
St. Bernardine Medical Center  
St. Helena Hospital\*  
St. Joseph Hospital\*  
St. Jude Medical Center  
St. Mary Medical Center Long Beach  
Stanford Hospital & Clinics\*  
Temecula Valley Hospital  
Torrance Memorial Medical Center\*  
Tri-City Medical Center  
UCLA Medical Center, Santa Monica\*  
UCSF Medical Center\*  
Ukiah Valley Medical Center\*  
White Memorial Medical Center

### COLORADO

Animas Surgical Hospital\*  
Avista Adventist Hospital\*  
Avista Surgery Center  
Castle Rock Adventist Hospital\*  
Denver Health Main Campus\*  
Littleton Adventist Hospital\*  
Medical Center of the Rockies\*  
Mercy Regional Medical Center\*  
OrthoColorado Hospital\*  
Parker Adventist Hospital\*  
Penrose Community Urgent Care  
Penrose Hospital\*  
Porter Adventist Hospital\*  
Poudre Valley Hospital\*  
St. Anthony Hospital\*  
St. Anthony North Hospital\*  
St. Anthony Summit Medical Center\*

St. Francis Medical Center\*  
 St. Mary-Corwin Medical Center\*  
 St. Mary's Medical Center\*  
 St. Thomas More Hospital\*  
 University of Colorado Hospital\*

#### CONNECTICUT

Connecticut Joint Replacement Institute\*  
 Hartford Hospital\*  
 Hospital of Central Connecticut\*  
 Johnson Memorial Hospital  
 MidState Medical Center  
 St. Mary's Hospital  
 St. Vincent's Medical Center\*

#### DELAWARE

Bayhealth Kent General\*  
 Bayhealth Milford Memorial\*  
 Christiana Hospital\*  
 Saint Francis Healthcare  
 Wilmington Hospital\*

#### DISTRICT OF COLUMBIA

George Washington University Hospital  
 Sibley Memorial Hospital\*

#### FLORIDA

Baptist Hospital  
 Bartow Regional Medical Center  
 Cape Coral Hospital  
 Cleveland Clinic Florida - Weston\*  
 Flagler Hospital\*  
 Gulf Breeze Hospital  
 Gulf Coast Medical Center  
 Health Central Hospital\*  
 Holy Cross Hospital  
 Indian River Medical Center\*  
 Jupiter Medical Center  
 Lakewood Ranch Medical Center  
 Largo Medical Center  
 Lee Memorial Hospital  
 Manatee Memorial Hospital  
 Martin Hospital South  
 Martin Medical Center  
 Mease Countryside Hospital  
 Mease Dunedin Hospital  
 Medical Center Clinic  
 Memorial Hospital West\*

Morton Plant Hospital  
 Morton Plant North Bay Hospital  
 South Florida Baptist Hospital  
 St. Anthony's Hospital  
 St. Joseph's Hospitals  
 St. Vincent's Medical Center Clay County  
 St. Vincent's Medical Center Riverside  
 St. Vincent's Medical Center Southside  
 The Orthopaedic Institute  
 Tradition Medical Center  
 Wellington Regional Medical Center  
 Winter Haven Hospital  
 Wuesthoff Medical Center - Rockledge

#### GEORGIA

Colquitt Regional Medical Center  
 Houston Medical Center\*  
 Memorial University Medical Center\*  
 Northside Medical Center  
 Optim Medical Center - Tattnell  
 Redmond Regional Medical Center\*  
 Southeast Georgia Health System\*  
 St. Mary's Good Samaritan Hospital  
 St. Mary's Hospital  
 WellStar Cobb Hospital  
 WellStar Douglas Hospital  
 WellStar Kennestone Hospital  
 WellStar Paulding Hospital  
 West Georgia Medical Center\*

#### HAWAII

Castle Medical Center\*  
 Pali Momi Medical Center\*  
 Straub Clinic and Hospital\*  
 Wilcox Memorial Hospital\*

#### IDAHO

Cassia Regional Medical Center  
 Northwest Specialty Hospital  
 Saint Alphonsus Medical Center - Nampa\*  
 Saint Alphonsus Regional Medical Center\*  
 St. Luke's Boise Medical Center\*

#### ILLINOIS

Advocate BroMenn Medical Center  
 Advocate Christ Medical Center  
 Advocate Condell Medical Center  
 Advocate Eureka Hospital

Advocate Good Samaritan Hospital  
 Advocate Good Shepherd Hospital  
 Advocate Illinois Masonic Medical Center  
 Advocate Lutheran General Hospital  
 Advocate Sherman Hospital  
 Advocate South Suburban Hospital  
 Advocate Trinity Hospital  
 Blessing Health System\*  
 Centegra Hospital McHenry\*  
 Centegra Hospital Woodstock\*  
 Genesis Medical Center, Silvis\*  
 Gottlieb Memorial Hospital  
 Loyola University Medical Center  
 Memorial Medical Center - Springfield\*  
 Mercy Hospital and Medical Center  
 NorthShore University HealthSystem  
 Evanston Hospital\*  
 NorthShore University HealthSystem  
 Glenbrook Hospital\*  
 NorthShore University HealthSystem  
 Highland Park Hospital\*  
 NorthShore University HealthSystem Skokie  
 Hospital\*  
 Northwestern Medicine Central DuPage  
 Hospital\*  
 Northwestern Medicine Delnor Hospital\*  
 Northwestern Memorial Hospital\*  
 Palos Community Hospital\*  
 Rockford Memorial Hospital\*  
 Rush University Medical Center\*  
 St. John's Hospital  
 SwedishAmerican Hospital  
 UnityPoint Health - Methodist\*  
 UnityPoint Health - Proctor\*  
 UnityPoint Health - Trinity Rock Island\*  
 Weiss Memorial Hospital  
 INDIANA  
 Ball Memorial Hospital\*  
 Bluffton Regional Medical Center  
 Dukes Memorial Hospital  
 Dupont Hospital  
 Franciscan St. Francis Health\*  
 Kosciusko Community Hospital  
 Lutheran Hospital  
 Major Hospital\*  
 Memorial Hospital and Health Care Center\*

OrthoIndy\*

Schneck Medical Center\*

St. Joseph Hospital

St. Joseph Plymouth Medical Center

St. Joseph Regional Medical Center

The Orthopedic Hospital

## IOWA

Allen Hospital\*

Baum Haron Mercy Hospital

Buena Vista Regional Medical Center\*

Central Iowa Healthcare Clinic -  
Marshalltown\*

Finley Hospital\*

Genesis Medical Center, Davenport\*

Great River Medical Center

Iowa Lutheran Hospital\*

Iowa Methodist Medical Center\*

Lakes Regional Healthcare

Marengo Memorial Hospital\*

Mercy Hospital - Council Bluffs\*

Mercy Hospital - Corning

Mercy Medical Center - Cedar Rapids

Mercy Medical Center - Des Moines\*

Mercy Medical Center - Dubuque

Mercy Medical Center - West Lakes\*

Mercy Medical Center-Clinton

Mercy Medical Center-Mason City

Mercy Medical Center-New Hampton

Mercy Medical Center-Sioux City

Methodist West Hospital\*

Spencer Hospital\*

St. Luke's Hospital\*

St. Luke's Regional Medical Center\*

Trinity Bettendorf\*

Trinity Muscatine\*

Trinity Regional Medical Center\*

University of Iowa Hospitals and Clinics\*

## KANSAS

Hutchinson Regional Medical Center\*

Kansas City Orthopaedic Institute\*

Newton Medical Center\*

Ransom Memorial Hospital

St. Catherine Hospital\*

St. Rose Ambulatory & Surgery Center

Stormont Vail Health\*

The University of Kansas Hospital\*

Wesley Medical Center\*

## KENTUCKY

Jewish Hospital

Methodist Hospital

St. Elizabeth Medical Center\*

St. Joseph East

## LOUISIANA

Doctors Hospital at Deer Creek\*

Lafayette Surgical Specialty Hospital

Ochsner Baptist - A Campus of Ochsner  
Medical Center\*

Ochsner Medical Center - Kenner\*

Ochsner Medical Center - Main Campus\*

Ochsner Medical Center - West Bank Campus\*

Our Lady of Lourdes Regional Medical Center

Specialists Hospital Shreveport\*

## MAINE

Falmouth Orthopaedic Center\*

Maine Medical Center Joint Replacement  
Center\*

## MARYLAND

Anne Arundel Medical Center

Atlantic General Hospital\*

Holy Cross Germantown Hospital

Holy Cross Hospital

Johns Hopkins Bayview Medical Center

MedStar Union Memorial Hospital\*

Meritus Medical Center\*

Peninsula Regional Medical Center

Sinai Hospital

University of Maryland Baltimore Washington  
Medical Center

University of Maryland Charles Regional  
Medical Center

University of Maryland Harford Memorial  
Hospital\*

University of Maryland Medical Center

University of Maryland Medical Center  
Midtown Campus

University of Maryland Rehabilitation and  
Orthopaedic Institute

University of Maryland Shore Medical Center  
at Easton\*

University of Maryland St. Joseph Medical  
Center\*

University of Maryland Upper Chesapeake

Medical Center\*

Western Maryland Health System\*

## MASSACHUSETTS

Berkshire Medical Center\*

Beth Israel Deaconess Hospital - Plymouth\*

Beth Israel Deaconess Medical Center\*

Beverly Hospital\*

Boston Medical Center\*

Good Samaritan Medical Center\*

Holy Family Hospital at Methuen

Massachusetts General Hospital\*

Mercy Medical Center

Mercy Medical Center of Sisters of Providence

New England Baptist Hospital

Quincy Medical Center\*

Saint Anne's Hospital\*

Signature Healthcare Brockton Hospital

South Shore Hospital

## MICHIGAN

Beaumont Hospital, Royal Oak Campus\*

Borgess Medical Center\*

Bronson Methodist Hospital\*

Henry Ford Hospital\*

Henry Ford Macomb Hospital\*

Henry Ford West Bloomfield Hospital\*

Henry Ford Wyandotte Hospital\*

Holland Hospital

Hurley Medical Center\*

Lakeland Health\*

McLaren Flint\*

McLaren Greater Lansing\*

McLaren Orthopedic Hospital \*

Mercy Health Hackley

Mercy Health Lakeshore

Mercy Health Muskegon

Mercy Health Saint Mary's

Mercy Health Southwest

Michigan Surgical Hospital\*

MidMichigan Medical Center - Midland\*

Munson Healthcare Cadillac Hospital\*

Munson Medical Center\*

Sparrow Hospital\*

St. Joseph Mercy Ann Arbor

St. Joseph Mercy Chelsea



St. Joseph Mercy Livingston Hospital  
St. Joseph Mercy Oakland  
St. Mary Mercy Hospital  
University of Michigan Health System\*  
UP Health System - Marquette\*

#### MINNESOTA

Abbott Northwestern - WestHealth  
Abbott Northwestern Hospital\*  
Buffalo Hospital\*  
Cambridge Medical Center\*  
CHI St. Gabriel's Health\*  
Crosstown Surgery Center\*  
Cuyuna Regional Medical Center\*  
Douglas County Hospital\*  
Essentia Health-St. Mary's Medical Center\*  
Fairview Lakes Medical Center\*  
Fairview Ridges Hospital\*  
Fairview Southdale Hospital\*  
Hennepin County Medical Center\*  
High Pointe Surgery Center\*  
Lakeview Hospital\*  
Maple Grove Hospital\*  
Mercy Hospital\*  
New Ulm Medical Center\*  
North Memorial Medical Center\*  
Owatonna Hospital\*  
Park Nicollet Methodist Hospital\*  
Regina Hospital\*  
Ridgeview Medical Center\*  
Riverwood Healthcare Center\*  
St. Francis Regional Medical Center\*  
St. John's Hospital  
St. Joseph Hospital\*  
Two Twelve Surgery Center\*  
United Hospital\*  
Unity Hospital\*  
Vadnais Heights Surgery Center\*  
WestHealth Surgery Center\*  
Woodwinds Health Campus\*

#### MISSISSIPPI

Baptist Medical Center\*  
Merit Health River Oaks\*  
North Mississippi Medical Center  
Ocean Springs Hospital\*

Singing River Hospital\*  
St. Dominic Hospital\*  
University of Mississippi Medical Center\*

#### MISSOURI

Mercy Hospital Springfield\*  
Meyer Orthopedic & Rehabilitation Hospital\*  
St. Luke's Hospital\*

#### MONTANA

Benefis Health System\*  
Providence St. Joseph Medical Center\*  
St. Patrick Hospital\*

#### NEBRASKA

Bergan Mercy Medical Center\*  
Creighton University Medical Center  
Good Samaritan Hospital  
Immanuel Medical Center\*  
Lakeside Hospital\*  
Lincoln Surgical Hospital\*  
Midlands Hospital\*  
Midwest Surgical Hospital  
Nebraska Medicine\*  
Nebraska Orthopaedic Hospital\*  
Oakland Memorial Hospital  
St. Elizabeth Regional Medical Center\*

#### NEVADA

Centennial Hills  
Desert Springs Hospital  
Northern Nevada Medical Center  
Renown Regional Medical Center\*  
Saint Mary's Regional Medical Center  
Spring Valley Hospital Medical Center  
Summerlin Hospital Medical Center  
Valley Hospital Medical Center

#### NEW HAMPSHIRE

Concord Hospital\*  
Dartmouth-Hitchcock Medical Center\*

#### NEW JERSEY

Chilton Medical Center  
Hackensack University Medical Center\*  
Lourdes Medical Center of Burlington County  
Morristown Medical Center\*  
Newton Medical Center\*  
Our Lady of Lourdes Medical Center  
Overlook Medical Center\*

Robert Wood Johnson University Hospital  
Robert Wood Johnson University Hospital  
Somerset

Saint Michael's Medical Center  
Saint Peter's University Hospital\*  
St. Francis Medical Center  
The Valley Hospital\*  
Virtua Marlton Hospital\*  
Virtua Memorial Hospital\*  
Virtua Voorhees Hospital\*

#### NEW MEXICO

Memorial Medical Center  
MountainView Regional Medical Center\*  
Presbyterian Hospital\*  
Presbyterian Rust Medical Center\*

#### NEW YORK

Albany Memorial Hospital  
Crouse Hospital\*  
Faxton St. Luke's Healthcare  
Glens Falls Hospital\*  
Hospital for Special Surgery  
Kenmore Mercy Hospital\*  
Mercy Hospital of Buffalo  
Montefiore Medical Center\*  
Mount St. Mary's Hospital  
New York Methodist Hospital\*  
New York-Presbyterian/Columbia University  
Medical Center\*  
New York-Presbyterian/Lower Manhattan  
Hospital  
New York-Presbyterian/Queens  
New York-Presbyterian/Weill Cornell Medical  
Center  
Oswego Hospital  
Sisters of Charity Hospital  
Sisters of Charity Hospital - St. Joseph  
Campus  
St. Elizabeth Medical Center\*  
St. Joseph's Hospital Health Center\*  
St. Mary Hospital  
St. Peter's Hospital\*  
The Hospital for Joint Diseases\*  
Unity Hospital\*  
Upstate University Hospital  
Winthrop-University Hospital\*



## NORTH CAROLINA

Blue Ridge Surgery Center - SCA - Surgical Care Affiliates  
Carolinas HealthCare System Lincoln  
Carolinas Medical Center  
Davie Medical Center  
FirstHealth Moore Regional Hospital\*  
Lexington Medical Center  
Mission Hospital\*  
New Hanover Regional Medical Center\*  
North Carolina Specialty Hospital\*  
Northern Hospital of Surry County\*  
Novant Health Brunswick Medical Center  
Novant Health Charlotte Orthopaedic Hospital\*  
Novant Health Forsyth Medical Center\*  
Novant Health Franklin Medical Center  
Novant Health Huntersville Medical Center  
Novant Health Kernersville Medical Center  
Novant Health Matthews Medical Center  
Novant Health Rowan Medical Center  
Novant Health Thomasville Medical Center  
OrthoCarolina  
Park Ridge Health  
Wake Forest Baptist Medical Center

## NORTH DAKOTA

CHI St. Alexius Health  
Sanford Medical Center\*

## OHIO

Amherst Family Health Center  
Anderson Hospital  
Ashtabula County Medical Center  
Bethesda North Hospital\*  
Blanchard Valley Hospital\*  
Clermont Hospital  
Cleveland Clinic Children's Hospital for Rehabilitation  
Cleveland Clinic Foundation\*  
Cleveland Clinic Lakewood\*  
Crystal Clinic Orthopaedic Center\*  
Euclid Hospital\*  
Fairfield Hospital  
Fairview Hospital\*  
Genesis Hospital  
Good Samaritan Hospital\*

Grant Medical Center\*  
Hillcrest Hospital\*  
Lutheran Hospital\*  
Marymount Hospital\*  
Medina Hospital\*  
Mount Carmel East  
Mount Carmel New Albany\*  
Mount Carmel St. Ann's  
Mount Carmel West  
OhioHealth Mansfield Hospital  
Selby General Hospital\*  
South Pointe Hospital\*  
Southwest General Health Center\*  
St. John Medical Center\*  
St. Vincent Charity Medical Center  
The Jewish Hospital  
The Ohio State University Wexner Medical Center\*  
TriHealth Evendale Hospital\*  
University Hospitals Ahuja Medical Center\*  
University Hospitals Case Medical Center\*  
University Hospitals Conneaut Medical Center\*  
University Hospitals Elyria Medical Center\*  
University Hospitals Geauga Medical Center\*  
University Hospitals Geneva Medical Center\*  
University Hospitals Parma Medical Center\*  
University Hospitals Portage Medical Center  
University Hospitals Regional Hospitals Bedford Campus\*  
University Hospitals Regional Hospitals Richmond Campus\*  
West Hospital

## OKLAHOMA

Community Hospital North Campus  
Community Hospital South Campus  
Duncan Regional Hospital\*  
Southwestern Medical Center  
St. Mary's Regional Medical Center  
Stillwater Medical Center\*

## OREGON

Adventist Medical Center\*  
Good Samaritan Regional Medical Center\*  
Legacy Emanuel Medical Center  
Legacy Good Samaritan Medical Center

Legacy Meridian Park Medical Center  
Legacy Mount Hood Medical Center  
Legacy Silverton Medical Center\*  
Oregon Orthopedic & Sports Medicine Clinic  
Providence Hood River Memorial Hospital\*  
Providence Medford Medical Center\*  
Providence Milwaukie Hospital\*  
Providence Newberg Medical Center\*  
Providence Portland Medical Center\*  
Providence Seaside Hospital\*  
Providence St. Vincent Medical Center\*  
Providence Willamette Falls Medical Center\*  
Saint Alphonsus Medical Center - Baker City\*  
Saint Alphonsus Medical Center - Ontario\*  
Salem Health  
Samaritan Albany General Hospital\*  
St. Charles Health System\*  
Tillamook Regional Medical Center\*  
Willamette Valley Medical Center\*

## PENNSYLVANIA

Allegheny General Hospital  
Chan Soon-Shiong Medical Center at Windber  
Children's Hospital of Pittsburgh of UPMC  
Doylestown Hospital\*  
Hanover Hospital\*  
Hospital of the University of Pennsylvania  
Indiana Regional Medical Center\*  
Lancaster General Hospital\*  
Magee-Womens Hospital of UPMC  
Mercy Fitzgerald Hospital  
Mercy Philadelphia Hospital  
Mount Nittany Medical Center\*  
Nazareth Hospital  
Orthopaedic & Spine Specialists\*  
Penn Presbyterian Medical Center\*  
Penn State Milton S. Hershey Medical Center\*  
Pennsylvania Hospital\*  
PinnacleHealth Community General Osteopathic Hospital\*  
PinnacleHealth Harrisburg Hospital\*  
PinnacleHealth West Shore Hospital\*  
Reading Hospital\*  
Regional Hospital of Scranton  
Rothman Institute  
St. Mary's Medical Center

Suburban Community Hospital  
 Thomas Jefferson University Hospital\*  
 UPMC Altoona  
 UPMC Beford Memorial  
 UPMC East  
 UPMC Hamot  
 UPMC Horizon  
 UPMC Jameson  
 UPMC McKeesport  
 UPMC Mercy  
 UPMC Northwest  
 UPMC Passavant-McCandless  
 UPMC Presbyterian  
 UPMC Shadyside  
 UPMC St. Margaret  
 WellSpan Gettysburg Hospital\*  
 WellSpan Surgery and Rehabilitation Hospital\*  
 WellSpan York Hospital\*

#### RHODE ISLAND

South County Hospital

#### SOUTH CAROLINA

Aiken Regional Medical Center  
 Baptist Easley Hospital\*  
 Bon Secours St. Francis Hospital\*  
 Carolina Pines Regional Medical Center  
 Conway Medical Center  
 East Cooper Medical Center\*  
 Medical University Hospital Authority (Medical University of South Carolina)\*  
 Novant Health Gaffney Medical Center  
 Palmetto Health Baptist\*  
 Palmetto Health Baptist Parkridge  
 Palmetto Health Richland\*  
 Providence Health\*  
 Roper Hospital\*  
 Roper St. Francis Mount Pleasant Hospital\*

#### SOUTH DAKOTA

Dunes Surgical Hospital  
 Sanford USD Medical Center\*  
 Sioux Falls Specialty Hospital

#### TENNESSEE

Baptist Memorial Hospital-Collierville\*  
 Henry County Medical Center  
 Indian Path Medical Center\*

Johnson City Medical Center\*  
 Maury Regional Medical Center\*  
 Memorial Hospital - Chattanooga\*  
 Memorial Hospital - Hixson  
 Physicians Regional Medical Center\*  
 Saint Thomas Midtown Hospital\*  
 Saint Thomas Rutherford Hospital  
 Saint Thomas West Hospital\*  
 University of Tennessee Medical Center\*

#### TEXAS

Baptist Beaumont Hospital of SouthEast Texas\*  
 Baylor Medical Center at Uptown  
 Baylor Scott & White - Fort Worth\*  
 Baylor Scott & White Medical Center - Carrollton\*  
 Baylor Scott & White Medical Center - Frisco\*  
 Baylor Scott & White Medical Center - Garland\*  
 Baylor Scott & White Medical Center - Grapevine\*  
 Baylor Scott & White Medical Center - Irving\*  
 Baylor Scott & White Medical Center - McKinney\*  
 Baylor Scott & White Medical Center - Plano\*  
 Baylor Scott & White Medical Center - Waxahachie\*  
 Baylor University Medical Center\*  
 CHRISTUS Southeast Texas St. Elizabeth\*  
 CHRISTUS Southeast Texas St. Mary\*  
 Cornerstone Regional Hospital  
 Doctors Hospital at Renaissance\*  
 Doctors Hospital of Laredo  
 Edinburg Regional Medical Center  
 El Paso Specialty Hospital\*  
 Fort Duncan Regional Medical Center  
 Good Shepherd Medical Center - Longview\*  
 Harlingen Medical Center\*  
 Houston Methodist Hospital  
 JPS Health Network\*  
 McAllen Medical Center  
 Memorial Hermann Memorial City Medical Center\*  
 Memorial Hermann Southwest Hospital\*  
 Midland Memorial Hospital\*  
 Nix Health\*

Northwest Texas Hospital  
 Scott & White Memorial Hospital - Temple\*  
 Seton Highland Lakes Hospital  
 Seton Medical Center - Austin\*  
 Seton Medical Center - Hays\*  
 Seton Medical Center - Williamson\*  
 Seton Northwest Hospital\*  
 Seton Southwest Hospital  
 South Texas Spine & Surgical Hospital\*  
 South Texas Surgical Hospital\*  
 St. Joseph Health System\*  
 Texas Health Harris Methodist Hospital Southwest Fort Worth\*  
 Texas Health Presbyterian Hospital Flower Mound  
 Texas Health Presbyterian Hospital Plano\*  
 Texas Health Presbyterian Hospital Rockwall\*  
 Texas Spine & Joint Hospital  
 Texoma Medical Center  
 The Physicians Centre Hospital  
 United Regional Health Care System\*  
 University Medical Center - Brackenridge\*  
 University of Texas Southwestern Medical Center\*  
**UTAH**  
 Alta View Hospital  
 American Fork Hospital  
 Bear River Valley Hospital  
 Cedar City Hospital  
 Dixie Regional Medical Center  
 Heber Valley Medical Center  
 Intermountain Medical Center  
 LDS Hospital  
 Logan Regional Hospital  
 McKay-Dee Hospital  
 McKay-Dee Surgical Center  
 Orem Community Hospital  
 Park City Hospital  
 Primary Children's Hospital  
 Riverton Hospital  
 Sevier Valley Hospital  
 TOSH - The Orthopedic Specialty Hospital  
 University of Utah Health Care\*  
 Utah Valley Hospital

## VERMONT

Northwestern Medical Center  
Rutland Regional Medical Center\*  
University of Vermont Medical Center\*

## VIRGINIA

Chippenham Hospital  
Inova Mount Vernon Hospital\*  
Johnston Memorial Hospital\*  
Mary Washington Hospital\*  
Novant Health Prince William Medical Center  
Reston Hospital Center\*  
Sentara CarePlex Hospital\*  
Sentara Leigh Hospital\*  
Sentara Martha Jefferson Hospital  
Sentara Norfolk General Hospital\*  
Sentara Northern Virginia Medical Center\*  
Sentara Obici Hospital\*  
Sentara Princess Anne Hospital\*  
Sentara RMH Medical Center\*  
Sentara Virginia Beach General Hospital\*  
Sentara Williamsburg Regional Medical Center\*  
University of Virginia Medical Center\*  
Virginia Hospital Center\*

## WASHINGTON

Ballard Campus\*  
Capital Medical Center  
Confluence Health  
Edmonds Campus\*  
EvergreenHealth Medical Center\*  
First Hill Campus\*  
Harrison Medical Center\*  
Highline Medical Center\*  
Issaquah Campus\*  
Kadlec Regional Medical Center\*  
Legacy Salmon Creek Medical Center  
Northwest Hospital & Medical Center\*  
Overlake Medical Center\*  
Providence Centralia Hospital\*  
Providence Holy Family Hospital\*  
Providence Mount Carmel Hospital\*  
Providence Regional Medical Center Everett - Colby\*  
Providence Regional Medical Center Everett - Pacific\*

Providence Sacred Heart Medical Center\*  
Providence St. Joseph's Hospital\*  
Providence St. Mary Medical Center\*  
Providence St. Peter Hospital\*  
St. Anthony Hospital\*  
St. Clare Hospital\*  
St. Elizabeth Hospital  
St. Francis Hospital\*  
St. Joseph Medical Center\*  
Valley Medical Center\*  
Virginia Mason Medical Center\*  
Walla Walla General Hospital\*  
Yakima Valley Memorial Hospital\*

## WEST VIRGINIA

Cabell Huntington Hospital\*  
Marshall Health  
Ruby Memorial Hospital\*

## WISCONSIN

Amery Hospital & Clinic\*  
Aspirus Wausau Hospital  
Aurora BayCare Medical Center\*  
Aurora Medical Center in Grafton\*  
Aurora Medical Center in Washington County\*  
Aurora Sinai Medical Center\*  
Aurora St. Luke's Medical Center\*  
Beloit Memorial Hospital  
Berlin Memorial Hospital\*  
Community Memorial Hospital of Menomonee Falls\*  
Fort Healthcare\*  
Froedtert Hospital\*  
Gundersen Health System\*  
HSHS St. Nicholas Hospital  
HSHS St. Vincent Hospital  
Hudson Hospital & Clinic\*  
Lakeview Medical Center\*  
Memorial Medical Center - Neillsville\*  
Mercy Hospital and Trauma Center\*  
Mercy Walworth Hospital and Medical Center\*  
Midwest Orthopedic Specialty Hospital\*  
Ministry Saint Mary's Hospital  
Monroe Clinic\*  
OakLeaf Surgical Hospital\*  
Oconomowoc Memorial Hospital\*  
Orthopaedic Hospital of Wisconsin\*

Osceola Medical Center\*  
River Falls Area Hospital\*  
Sauk Prairie Hospital\*  
SSM Health St. Clare Hospital - Baraboo  
SSM Health St. Mary's Hospital - Janesville  
SSM Health St. Mary's Hospital - Madison  
St. Croix Regional Medical Center  
St. Joseph's Hospital\*  
St. Mary's Hospital Medical Center  
The Orthopedic and Sports Surgery Center  
ThedaCare Medical Center-New London\*  
ThedaCare Medical Center-Shawano\*  
ThedaCare Medical Center-Waupaca\*  
ThedaCare Regional Medical Center-Appleton\*  
ThedaCare Regional Medical Center-Neenah\*  
Tomah Memorial Hospital  
UnityPoint Health - Meriter\*  
University of Wisconsin Hospital and Clinics\*  
Waukesha Memorial Hospital\*  
Westfields Hospital & Clinic\*  
**WYOMING**  
Cheyenne Regional Medical Center\*  
Mountain View Regional Hospital  
St. John's Medical Center\*

# Appendix D ICD-9 & ICD-10 Procedure Code Categories

## Primary Hip Replacement

### ICD-9

- 81.51 Total Hip Replacement
- 81.52 Partial Hip Replacement

### ICD-10

- OSR9xxx Replacement of Right Hip Joint
- OSRBxxx Replacement of Left Hip Joint
- OSRAxxx Replacement of Right Hip Joint, Acetabular Surface
- OSRExxx Replacement of Left Hip Joint, Acetabular Surface
- OSRRxxx Replacement of Right Hip Joint, Femoral Surface
- OSRSxxx Replacement of Left Hip Joint, Femoral Surface

## Revision Hip Replacement

### ICD-9

- 00.7 Other Hip Procedures
- 00.70 Revision of Hip Replacement, both Acetabular and Femoral Components
- 00.71 Revision of Hip Replacement, Acetabular Component
- 00.72 Revision of Hip Replacement, Femoral Component
- 00.74 Hip Bearing Surface, Metal-on-Polyethylene
- 81.53 Revision of Hip Replacement, Not Otherwise Specified

### ICD-10

- OQPxxxx- Removal (acetabulum, upper femur, etc.)  
xxxxxxx
- OSPxxxx- Removal, Hip Joint  
xxxxxxx
- OSWxxxx- Revision, Hip Joint  
xxxxxxx

## Hip Resurfacing

### ICD-9

- 00.85 Resurfacing Hip, Total, Acetabulum and Femoral Head
- 00.86 Resurfacing Hip, Partial, Femoral Head
- 00.87 Resurfacing Hip, Partial, Acetabulum

### ICD-10

- OSUBxxx Supplement, Left Hip Joint
- OSU9xxx Supplement, Right Hip Joint
- OSUAxxx Supplement Right Hip Joint, Acetabular Surface
- OSUExxx Supplement Left Hip Joint, Acetabular Surface
- OSURxxx Supplement Right Hip Joint, Femoral Surface
- OSUSxxx Supplement Left Hip Joint, Femoral Surface

## Primary Knee Replacement

### ICD-9

- 81.54 Total Knee Replacement

### ICD-10

- OSRCxxx Replacement of Right Knee Joint
- OSRDxxx Replacement of Left Knee Joint
- OSRTxxx Replacement of Right Knee Joint, Femoral Surface
- OSRUxxx Replacement of Left Knee Joint, Femoral Surface
- OSRVxxx Replacement of Right Knee Joint, Tibial Surface
- OSRWxxx Replacement of Left Knee Joint, Tibial Surface
- OQRDxxx Replacement of Right Patella
- OQRFxxx Replacement of Left Patella
- OSUCxxx Supplement Right Knee Joint
- OSUDxxx Supplement Left Knee Joint
- OSUVxxx Supplement, Right Knee Joint, Tibial Surface
- OSUWxxx Supplement, Left Knee Joint, Tibial Surface
- OQUDxxx Supplement, Right Patella
- OSUUxxx Supplement, Left Knee Joint, Femoral Surface

## Revision Knee Replacement

### ICD-9

- 00.80 Revision of Knee Replacement, Total (all components)
- 0.81 Revision of Knee Replacement, Tibial Component
- 0.82 Revision of Knee Replacement, Femoral Component
- 0.83 Revision of Knee Replacement, Patellar Component
- 0.84 Revision of Total Knee Replacement, Tibial Insert (liner)
- 81.47 Other Repair of Knee
- 81.55 Revision of Knee Replacement, Not Otherwise Specified

### ICD-10

- OQPxxxx- Removal (from patella, from tibia, etc.)  
xxxxxxx
- OSPxxxx- Removal, Knee Joint  
xxxxxxx
- OSWxxxx- Revision, Knee Joint  
xxxxxxx

## Appendix E ICD-9 & ICD-10 Diagnosis Code Categories included for Hips

### ICD-9

- 714 Rheumatoid Arthritis
- 715 Osteoarthritis (of hip, of knee)
- 716 Other and Unspecified Arthropathies
- 719 Other and Unspecified Disorders of Joint; Other Joint Disorder, Not Elsewhere Classified
- 733 Other Disorders of Bone and Cartilage; Disorder of Continuity of Bone
- 820 Fracture of Neck of Femur; Fracture of Femur
- 996 Complications Peculiar to Certain Specified Procedures; Complications of Internal Orthopedic Prosthetic Devices, Implants, and Grafts; Complications of Other Internal Prosthetic Devices, Implants, and Grafts

### ICD-10

- M06 Rheumatoid Arthritis
- M16-M17 Osteoarthritis (of hip, of knee)
- M12 Other and Unspecified Arthropathies
- M25 Other and Unspecified Disorders of Joint; Other Joint Disorder, Not Elsewhere Classified
- M84 Other Disorders of Bone and Cartilage; Disorder of Continuity of Bone
- S72 Fracture of Neck of Femur; Fracture of Femur
- T84-T85 Complications Peculiar to Certain Specified Procedures; Complications of Internal Orthopedic Prosthetic Devices, Implants, and Grafts; Complications of Other Internal Prosthetic Devices, Implants, and Grafts

## Appendix F ICD-9 & ICD-10 Diagnosis Code Categories included for Knees

### ICD-9

- 715 Osteoarthritis (of hip, of knee)
- 716 Other and Unspecified Arthropathies
- 719 Other and Unspecified Disorders of Joint; Other Joint Disorder, Not Elsewhere Classified
- 996 Complications Peculiar to Certain Specified Procedures; Complications of Internal Orthopedic Prosthetic Devices, Implants, and Grafts; Complications of Other Internal Prosthetic Devices, Implants, and Grafts

### ICD-10

- M16-M17 Osteoarthritis (of hip, of knee)
- M12 Other and Unspecified Arthropathies
- M25 Other and Unspecified Disorders of Joint; Other Joint Disorder, Not Elsewhere Classified
- T84-T85 Complications Peculiar to Certain Specified Procedures; Complications of Internal Orthopedic Prosthetic Devices, Implants, and Grafts; Complications of Other Internal Prosthetic Devices, Implants, and Grafts



# References

1. American Hospital Association. *Fast Facts US Hosp.* 2016. <http://www.aha.org/research/rc/stat-studies/fast-facts.shtml>. Accessed September 22, 2016.
2. McGrory BJ, Etkin CD, Lewallen DG. Comparing contemporary revision burden among hip and knee joint replacement registries. 2016; 2:83-86 doi:10.1016/j.artd.2016.04.003.
3. Baker RP, Squires B, Gargan MF BG. Total hip arthroplasty and hemiarthroplasty in mobile, independent patients with a displaced intracapsular fracture of the femoral neck. A randomized, controlled trial. 2006;88(12):2583-2589. doi:10.2106/JBJS.E.01373.
4. Blomfeldt R, Törnkvist H, Eriksson K, et al. A randomised controlled trial comparing bipolar hemiarthroplasty with total hip replacement for displaced intracapsular fractures of the femoral neck in elderly patients. *J Bone Jt Surg [Br]*. 2007;89:160-165. doi:10.1302/0301-620X.89B2.
5. Macaulay W, Nellans KW, Garvin KL, Iorio R, Healy WL RM. Prospective Randomized Clinical Trial Comparing Hemiarthroplasty to Total Hip Arthroplasty in the Treatment of Displaced Femoral Neck Fractures Winner of the Dorr Award. *J Arthroplast.* 2008;23(6 (Suppl 1)):2-8. doi:10.1016/j.arth.2008.05.013.
6. Yu L, Wang Y CJ. Total Hip Arthroplasty Versus Hemiarthroplasty for Displaced Femoral Neck Fractures: Meta-analysis of Randomized Trials. *Clin Orthop Relat Res.* 2012;470(8):2235-2243 doi: 10.1007/s11999-012-2293-8.
7. Australian Orthopaedic Association National Joint Replacement Registry. *Hip and Knee Arthroplasty Annual Report*. Adelaide, Australia; 2015. <https://aoanjrr.sahmri.com/documents/10180/217745/Hip and Knee Arthroplasty>.
8. National Joint Registry. *12th Annual Report National Joint Registry for England, Wales, Northern Ireland and the Isle of Man*. Hertfordshire UK; 2015. <http://www.njrcentre.org.uk/njrcentre/Portals/0/Documents/England/Reports/12th annual report/NJR Online Annual Report 2015.pdf>.
9. Mistry JB, Chughtai M, Elmallah RK, et al. Trunnionosis in total hip arthroplasty: a review. *J Orthop Traumatol.* 2016; 17:1-6 doi:10.1007/s10195-016-0391-1.
10. Cooper HJ, Della Valle CJ, Berger RA, et al. Corrosion at the head-neck taper as a cause for adverse local tissue reactions after total hip arthroplasty. *J Bone Joint Surg Am.* 2012;94(18):1655-1661. <http://doi:10.1007/s10195-016-0391-1>.
11. Glyn-Jones S, Thomas GER, Garfield-Roberts P, Gundle R, Taylor A, McLardy-Smith P MD. The John Charnley Award: Highly crosslinked polyethylene in total hip arthroplasty decreases long-term wear: a double-blind randomized trial. *Clin Orthop Relat Res.* 2015;473(2):432-438. doi:s11999-014-3735-2 doi: 10.1007/s
12. Bedard NA, Callaghan JJ, Stefl MD, Willman TJ, Liu SS GD. Fixation and wear with a contemporary acetabular component and cross-linked polyethylene at minimum 10-year follow-up. *J Arthroplast.* 2014;29(10):1961-1969 doi: 10.1016/j.arth.2014.05.008.
13. Lindalen E, Nordsletten L, Høvik Ø, Röhrli SM. E-vitamin infused highly cross-linked polyethylene: RSA results from a randomised controlled trial using 32 mm and 36 mm ceramic heads. *Hip Int.* 2015;25(1):50-55. doi:10.5301/hipint.5000195.
14. Paxton EW, Inacio MCS, Namba RS, Love R, Kurtz SM. Metal-on-conventional Polyethylene Total Hip Arthroplasty Bearing Surfaces Have a Higher Risk of Revision Than Metal-on-highly Crosslinked Polyethylene: Results From a US Registry. *Clin Orthop Relat Res.* 2015;473(3):1011-1021. doi:10.1007/s11999-014-4105-9.
15. Epinette JA. Clinical outcomes, survivorship and adverse events with mobile-bearings versus fixed-bearings in hip arthroplasty - a prospective comparative cohort study of 143 ADM versus 130 trident cups at 2 to 6-year follow-up. *J Arthroplast.* 2015;30(2):241-248 doi: 10.1016/j.arth.2014.09.022.
16. Philippot R, Adam P, Reckhaus M, et al. Prevention of dislocation in total hip revision surgery using a dual mobility design. *Orthop Traumatol Surg Res.* 2009;95(6):407-413 doi: 10.1016/j.otsr.2009.04.016.
17. van Heumen M, Heesterbeek PJC, Swierstra BA, Van Hellemond G, Goosen JHM. Dual mobility acetabular component in revision total hip arthroplasty for persistent dislocation: no dislocations in 50 hips after 1-5 years. *J Orthop Traumatol.* 2015;16(1):15-20. doi:10.1007/s10195-014-0318-7.
18. Vielpeau C, Lebel B, Ardouin L, Burdin G, Lautridou C. The dual mobility socket concept: experience with 668 cases. *Int Orthop.* 2011;35(2):225-230. doi:10.1007/s00264-010-1156-8.
19. Kop AM, Keogh C SE. Proximal component modularity in THA—at what cost? An implant retrieval study. *Clin Orthop Relat Res.* 2012;470(7):1885-1894 doi: 10.1007/s11999-011-2155-9.
20. Walsh CP, Hubbard JC, Nessler JP MD. Revision of recalled modular neck Rejuvenate and ABG femoral implants. *J Arthroplast.* 2015;30(5):822-826 doi: 10.1016/j.arth.2014.12.002 doi: 10.1016/j.arth.2015.04.039.
21. Ghanem E, Ward DM, Robbins CE, Nandi S, Bono JV TC. Corrosion and adverse local tissue reaction in one type of modular neck stem. *J Arthroplast.* 2015;30(10):1787-1793.
22. Bernstein DT, Meftah M, Paraniham J IS. Eighty-six Percent Failure Rate of a Modular-Neck Femoral Stem Design at 3 to 5 Years Lessons Learned. *J Bone Jt Surg Am.* 2016;98(12):e49 doi: 10.2106/JBJS.15.01082.
23. Swedish Knee Arthroplasty Register. *Annual Report 2015*. Lund, Sweden



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